CHEMICAL
& METALLURGICAL
# ENGINEERING

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MARCH 1939

What's ahead

Good News

How much should a chemical engineer know about equipment design? Needs differ, but the fundamental requirement is to be able to design or at least specify *workable* equipment from which the operator can get the utmost. This takes more than familiarity with the unit operations, strength of materials, and the drawing board. That "plus" is experience. A pint of the "functional," and a pound of the "mechanical," plus a strong flavoring of crystallized experience is the recipe for the fare being prepared now for May's Chemical Process Equipment Design Number. You're invited to dinner.

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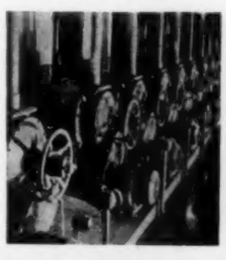

Cover picture showing grinding mills in the paint plant of the Pittsburgh Plate Glass Co. at Milwaukee, Wis. Other pictures appear in the pictured flow sheet on pages 157–160 of this issue. [*This cover released for editorial use by The Patterson Foundry & Machine Co.*]

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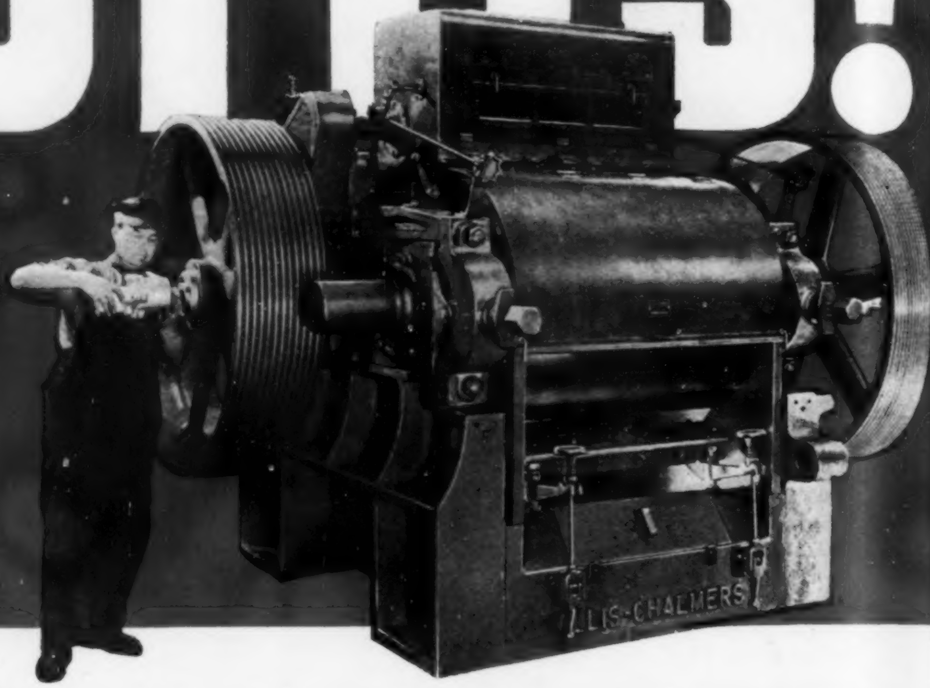
PROFITS!

IN NEW PROCESSING METHODS!



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CHEMICAL
& METALLURGICAL
ENGINEERING
ESTABLISHED 1902

MARCH, 1939

S. D. KIRKPATRICK, *Editor*

Piece-Meal Preparedness

THE STORY GOES that shortly after the United States entered the World War, our military authorities suddenly discovered that an enterprising harness buyer in the Quartermaster Corps had virtually cornered the entire leather supply of the country. He was going to make certain that the Army mules were properly fitted out even if the doughboys went without shoes and the officers had no Sam Brown belts. As we now look back on that comedy of errors, it seems ridiculous that one branch of the service should compete with another branch of the service in buying the necessities of war. We are told that comparable situations could not possibly develop under the present procurement program. We sincerely hope this is true, especially in connection with plans for the many chemicals which are so vital to the national defense.

Phenol is a case in point. In the event of war the demand for this raw material for gas and explosives manufacture would be tremendous—far in excess of all peace-time requirements. Today most phenol probably goes into plastics of phenolic-resin type. But supposing that in its procurement programs, Ordnance or Chemical Warfare, separately or together, were planning to take all the available phenol. Where, under such circumstances, would the Signal Corps get the insulating panels and instrument cases so essential for radio communication? Where would the Medical Corps get its U.S.P. phenol and medicinals made from it?

Supplies of even so essential a material as chlorine are not easily allocated as between peace- and war-time uses. Many of its applications, as in the purification of water and the prevention of disease, cannot be tampered with. Other uses in bleaching textiles or paper seem less vital, but could conceivably have real military significance. And in chemical syntheses chlorine finds many uses that closely parallel the manufacture of poison gases and high explosives. Therefore, it is not at all easy to say that the present industry can or cannot supply all *essential* demands in the event of war.

What seems to be needed, in addition to the excellent procurement plans that are outlined in this issue by Colonel Toulmin and Captain Kuhn, is some over-all Board of Chemical Strategy. Its first job should be to ascertain in cooperation with the Army and Navy exactly what would be their chemical requirements—not only for chemicals *per se*, but also for essential materials in which chemicals are used. A comparable study should then be made of all normal industrial requirements and their relation to any possible war-time demands. Present capacities will have to be ascertained in certain industries. Only then and with the complete knowledge of all chemical requirements will the board be ready to allocate production or arrange for necessary plant expansion.

Few chemical manufacturers are going to enter enthusiastically into any program that threatens a war-time boom with the inevitable collapse that is still so fresh in our memories. Nevertheless they realize their important responsibilities and may be counted on to do their part in any plan of industrial mobilization. But the government authorities must keep constantly in mind that there can be no piece-meal preparedness as far as chemical industry is concerned. Chemicals are so vital to so many different branches of the service and so many peace-time industries, that a comprehensive, over-all chemical program is absolutely necessary at the very start.

From an

INCOME SECURITY

SEASONAL EMPLOYMENT is not general among the chemical industries although it has long been a thorn in the side of fertilizer manufacturers. That they are attempting to ease the hardships to workers caused by the long periods during which income is either eliminated or reduced to a very low figure is shown by the recently inaugurated Income Security Plan of the Davison Chemical Corp.

In order for an employee to be eligible for benefits under the plan he must have completed three years of service with the company. Whenever an eligible employee's weekly wage falls below thirty hours pay at his current rate due to lack of work, the company will advance him the difference between his actual earnings and the equivalent of thirty hours' pay. Whenever his total earnings in a subsequent week are in excess of an amount equal to thirty hours' pay at his current rate, one-half of the excess will be treated as work performed for, and will be applied against, advances theretofore made until fully repaid. While it is recognized that this plan is an experiment it is to be hoped that it will help to correct, at least partially, the existing situation in the fertilizer industry.

WHERE BUSINESS IS BETTER

A RECENT SURVEY among executives of about 125 companies in the East and Middle West revealed a significant commentary on business prospects for the capital-goods industries. Whereas the investigators (representing one of the important investment trusts), found that the very largest companies had no such impressive plant expansion programs as those that reach boom-like proportions late in 1936 and early in 1937, nevertheless the total showing seemed to point toward a substantial improvement. Let us quote their reasoning:

"It is quite possible that in the current recovery it will be the second-line, smaller companies, which will spend most money for more modern and cost-saving equipment in order to compete successfully with their larger competitors. In fact in several industries that we checked with both large and small companies, it was the smaller companies whose expenditure budgets for 1939 compared most favorably with 1938 and earlier years. And the relatively favorable reports from machinery and equipment manufacturers indicated that certainly some concerns were ordering more for capital improvements than in 1938."

Fifty companies, whose aggregate expenditures for capital improvements normally account for about a fifth of the total for the entire country, reported that they would spend 15 per cent less in 1939 than in 1938, 55 per cent less than in 1937 and 30 per cent less than in 1936. Yet by eliminating the ten companies which had made the largest expenditures in 1937, the picture is entirely altered. The remaining forty companies in 1939 reported that they would spend 10 per cent more than in 1938, and only 30 per cent less than in 1937 and nearly 15 per cent more than in 1936. The report concludes: "As was the case in 1936 and 1937, most capital expenditures will be for machinery and other equipment aimed at saving costs and eliminating labor. Such plans as were uncovered for building new factories were chiefly for new products (notably in the chemical industry) or in connection with decentralizationon programs."

These views check pretty well with our own as regards the more important place of the smaller companies in chemical engineering activity at the present time. There is more revamping and modernization work going on than is apparent on the surface. One does not hear so much about the little fellows but in the aggregate they are extremely important. It is encouraging to find them coming into their own.

WHO OWNS AMERICAN INDUSTRY?

OWNERSHIP STUDIES have been made in recent years by many American corporations, whose executives and employees have often been surprised to discover the identity of their real bosses. In this way the old myth about the "sixty families" that control the assets of our country can be quickly exploded. But what is more important, these studies bring home to all of us that American industry is a much more democratic institution than is generally realized. It draws its support and resources from common people in every walk of life. Hence anything that affects its future—favorably or unfavorably—becomes a matter of deep

Editorial Viewpoint

concern to a very substantial cross-section of the American public.

This was brought home in a striking way last month in a unique survey which Monsanto Chemical Company had completed, primarily for its own employees. This analysis revealed that its American shares were held by some 10,000 stockholders of which almost 4,000 were men and more than 3,700 were women. Of the remaining 2,500, about 300 were joint owners such as husbands and wives or business partners, 1,600 were estates and public trusts, 70 were insurance companies (with 25,000,000 policy holders), 35 were investment trusts (with 170,000 shareholders), 120 were hospitals, charitable or educational foundations and 40 were universities and colleges.

To get away from cold, inanimate statistics, Monsanto went a step further with its research. Cincinnati was selected as a typical American city in which this typically American company had neither plants nor laboratories. Interviewers and photographers were assigned to talk with and photograph every Monsanto stockholder, from "Spuds" Crossett, the potato merchant to a director of the world's largest chain of grocery stores, from Cecil H. Gamble of the Procter and Gamble Company to young Jim Simmons who works as an analyst in the P. and G. laboratories. Interesting pictures and stories about these typical Cincinnatians find their way into the January issue of *Monsanto Magazine*. Now every employee of that company has a dramatic, colorful collection of intimate information about the sort of people that are his real bosses.

It cost considerable to make this study but from the interest it has aroused both within the company and on the outside, it would seem to have been distinctly worth while. All of chemical industry is benefitted by this sort of public relations work. More companies, large and small, should be doing the same thing.

SAFER SAFETY GLASS

IN RECOGNITION of their efforts toward reducing hazards through the development of modern safety glass, five companies, three in the chemical and two in the glass industry, will be honored by the Franklin Institute at a dinner on March 31 following a demonstration of the new vinyl type of safety glass. The corporations to be honored are Carbide and Carbon Chemicals Corp., E. I. du Pont de Nemours & Co., Monsanto Chemical Co., Libby-Owens-Ford Glass Co. and Pittsburgh Plate Glass Co.

The newer type of glass, first announced in *Chem. & Met.* in April, 1936, is the third major step in the evolution of laminated safety glass. The original product included a sheet of cellulose nitrate. This was supplanted by cellulose acetate, which in turn is now being replaced in the glass used in several makes of automobiles by a vinyl resin. It offers the very important advantage of retaining its high degree of flexibility at all temperatures and under all weather conditions, thus greatly lessening the possibilities of injuries to occupants of automobiles. It is an achievement of which these companies should be justly proud and for which the public should be grateful.

ADVICE TO NAME COINERS

THE SUPREME COURT says that "shredded wheat biscuit" is merely the common descriptive name of a breakfast cereal offered in pillow-shaped form. With the expiration of the patents which covered the process of making this commodity, the art of manufacture became public property and the name as well was dedicated to the public, because it was merely a descriptive sort of trade name.

Those who choose the names for new products must study well this decision of mid-November. It means that building up by advertising and service of a great goodwill around a name which is merely generic and descriptive, is not safe. In due time that name, as well as the patented processes or products, become available to all.

And those who struggle with the naming of things have not done the whole job when they have picked the right cognomen for a new product or a new kind of goods. They must protect that name against improper applications, in order to retain it as their private property. The loss of the exclusive use of "cellophane" by duPont, under final court decision sometime ago, proved that.

There *is* a lot in a name, despite the old adage to the contrary.

More than 90 per cent of the planes we used in 1917–1918 were of foreign make

Why Wars

IN ADDITION to Col. Toulmin's work as patent counsel for manufacturing corporations and his familiarity with their operations and problems, he has had practical experience, both in war and peace, in the design and supply of war materials. As a responsible officer in charge of thousands of troops in France using such materials, he has learned what it takes to satisfy the actual demands of war in the field. He has been, successively, Assistant Secretary, General Munitions Board of the Council of National Defense; Captain of Ordnance and Executive Assistant of the Gun Division of the Ordnance Department, Major of Ordnance and Chief of the Aircraft Armament Division in France, Lt.-Col. and Chief of the Coordination Staff of the U. S. Army Air Corps of the World War in France, in which he discharged the duties of Assistant Chief of Staff of a Corps of 70,000 men and officers in France, England and Italy. He was awarded the Distinguished Service Medal.

Since the War, he has been a Colonel of Engineers and is now a Colonel of Infantry, commanding the 329th Inf. He is also a Colonel of Field Artillery and Colonel of Coast Artillery (Anti-Aircraft). Col. Toulmin has served with the Regular Army, the National Guard and the Reserves.—Editor.

SUCCESS IN NATIONAL REARMAMENT depends upon correct fundamental policies. Until these practical requirements of industrial mobilization are met and the needs of the war machine in the field are understood, it is folly to launch an industrial mobilization program. There are rules in this game of making ready for war and conducting it that long experience in both war and peace have taught us will work where others will not work.

Let me illustrate some of these essential policies. The question of design in airplane motors is a good case in point. When we entered the World War in the spring of 1917, there were some satisfactory designs of aviation motors which, if they had been reproduced in quantity, would have carried us along successfully in the development of our air program for the first six to twelve months. Instead, we made the fatal error of attempting to design a new and better motor known as the "Liberty Motor," so that it was not until the middle of 1918 that two of those motors ever got to France, and then both of them proved to be defective. In the meantime, the only motors that we had for use abroad were in the 9,000 planes that we purchased from France and England.

We made the same error with planes. Instead of duplicating existing designs so as to have a supply of such planes while developing better ones, we thought that we could build finer planes and tried to do so. Not only did we fail to produce planes until very late in the war, but those we did ship initially were vitally defective and had to be redesigned and rebuilt in France. Only 683 planes of American manufacture were in active operation on the Front when the Armistice was signed. In the meantime, we had purchased the 9,000 planes abroad which represented our training and combat aircraft overseas.

This passion for starting from the beginning instead of establishing the policy of making what was reasonably good until the new design was in process of production led us into strange difficulties.

The story of our supply of field artillery was the duplicate of the story of our aircraft production. I remember distinctly the embarrassment of a member of the French Military Mission in the late fall of 1917, when he called to advise me that one of our leading ordnance officers of the Regular Army had forgotten, in redesigning this 75 millimeter gun, to make the shell and gun fit. Instead of duplicating the French gun and the French ammunition, this officer and his associates had followed the wrong mobilization armament policy of trying to design a better gun. And a great smoke screen was put up about the whole procedure, which difficulty should not have existed.

General Crozier and the writer visited the munitions works in France in the spring of 1918 to inspect the highly secret recoil loading procedure for the 75 mm. gun and we were astounded to find that it was being accomplished with a few workmen and the simplest sort of mechanism. This was one of the great military secrets of Europe.

So lesson Number 1 is start out

S

Are Won in Factories

Our own World War experience and that of other nations demonstrated convincingly that certain fundamental policies of national defense must be adopted and rigorously applied in any successful program of industrial mobilization.

COL. H. A. TOULMIN, JR.
Toulmin & Toulmin
Dayton, Ohio

with known and tried designs, getting them into production before making something better.

Here is an illustration of the second principle of industrial mobilization. When the designs are established, the thing that delays production is that important question of jigs, tools, fixtures, gages and measuring instruments. These are the things that must be prepared in advance with the utmost care, for they take a long time to produce in quantity. There must be no stinting of effort prior to war in getting this equipment together. The bottle neck of war-time production was the measuring gage.

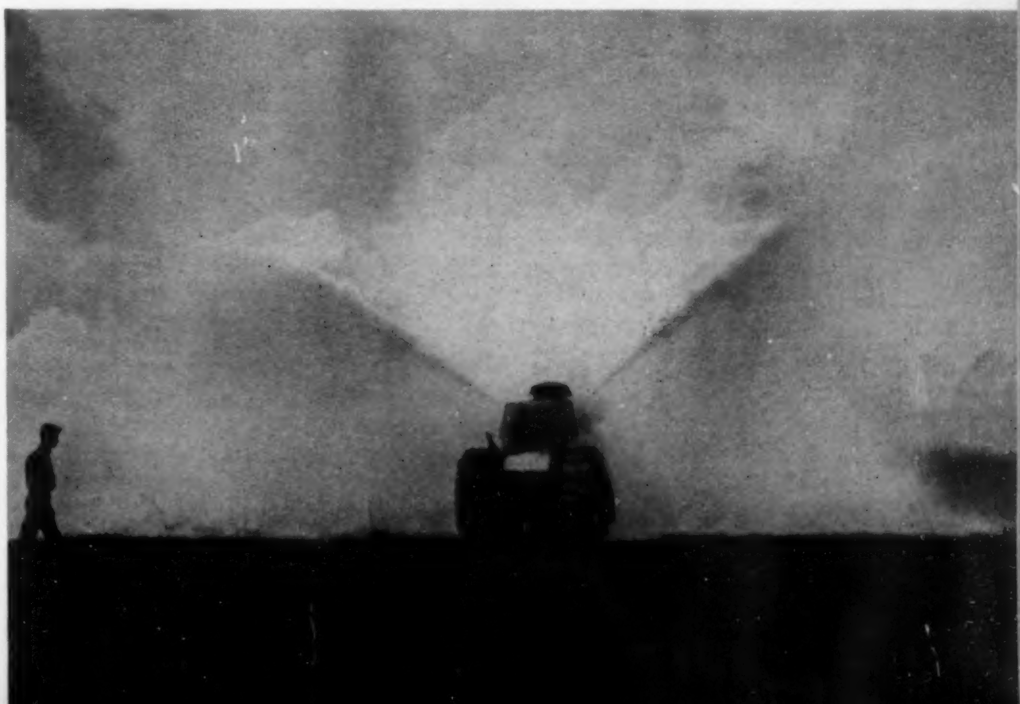
The third fundamental policy is that typical processes and methods should be worked out in pilot plants, or shadow plants, in order to train civilian personnel. If every plant has as its Exhibit A, a small model plant for munitions production in its special field, then a reserve of trained workmen can be built up who can rotate in getting experience on this model set-up, which can be multiplied and expanded quickly in time of war, because it will be known definitely what is wanted and men will be trained to do exactly that.

The next lesson in fundamental policy starts right out at the Front where troops are operating. One or two illustrations from practical experience will best demonstrate that war is successful in proportion to the standardization of supplies. A nation may have the finest equipment in the world, but if it has too much of it by having too many things with too many parts, its whole campaign will bog down in a morass of confusion.

When we started organizing our air corps in France, we ran square against this problem. Our army used thirty caliber ammunition in its rifles and machine guns. A number of our squadrons were to be initially brigaded with the French, who used a 0.303 ammunition. The planes that we were buying had ammunition boxes for the machine gun belts that fit the French ammunition, but not for ours. The question of policy was: Shall we take equipment as it is supplied and commit ourselves to foreign ammunition which we can not satisfactorily secure when we create our own corps, or shall we get the equipment fundamentally right in the beginning for thirty caliber ammunition? Fortunately, we selected the latter as the correct policy, because otherwise, in our army, we would have had to handle two different types of ammunition, which would have been fatal.

Right now, our army must decide on this question of standardization of vehicles. Nothing could be more disastrous than arbitrarily to follow the law and ask for bids on half-ton trucks, the specifications of which could be met by a half-dozen bidders. This will mean that we will have one-half dozen different trucks, and that in the field, we must have one-half dozen different supplies of repair parts. From my own experience, I know that you can always get five kinds of repair parts, but

Tanks that spread smoke screens



never the one you want in an emergency.

Take the case of our tanks, which have 22,000 parts. Let us multiply that problem by having one-half dozen different kinds and sizes of tanks, a variety of models of each kind, and in addition to that, armored cars, combat cars and reconnaissance cars, together with machine gun carriers. We have both full track and half track, six wheeled and four wheeled, and in some cases, twelve wheeled drive vehicles.

Confusion Must Be Eliminated

This is confusion worse confounded in two ways: in the field, it is impossible to keep such vehicles in operation because we can not stock the supplies and service the vehicles in the field. It takes a master mind to handle simple repairs for simple mechanisms with troops in the field.

But worse yet, the condition behind the lines where production is going on is even tougher. In a great nation of automotive manufacturers like ours, we need standardization as a fundamental policy of mobilization. We must eliminate from our war vehicles multiple types and special parts and constructions. It is far better to have one hundred vehicles of ordinary performance operating, than one-half dozen super vehicles with the balance in the ditch or in the repair shop because they are so highly specialized that they can not be kept in operation and repair.

I have seen some of our latest mechanized vehicles that required in time of peace, after an hour or two of field work, five to seven hours in the shop. Compare that situation with the requirements of war of 24-hour duty in mud, snow, sleet, dust and intense heat. It is only the simple, the strong and the standardized equipment that can be fought successfully in the field, and it is the only kind that can be produced in sufficient quantities to supply a modern army.

Another fundamental policy is to determine accurately the conditions under which the equipment will operate. When we use machine guns in the air, we wipe off the lubricant because of the low temperature under which the gun must operate. It is an air-cooled gun. Down on the ground, that same gun is water cooled and fully lubricated. The ground machine gun need not have the most perfect parts, but the air gun must have each part examined with a magnifying glass so that fully 20 per cent of its parts which would be perfectly satisfactory on the ground must be discarded for imperfections. A fundamental rule of policy is that the weapon or equipment must be made with some knowledge of how it is going to be used in actual service.

In the recent Spanish War, rubber treads on mechanized vehicles have proved disastrous. In Madrid, Spanish soldiers discovered that a few pop bottles of gasoline tossed against the sides of the best German or Italian tanks with rubber treads, followed by a hand grenade, would burn off the treads, crippling the tank and either burning up the personnel or flushing them from the tank so that they could be easily shot. It was discovered that the reinforcing angle irons on the bottom of the tank acted as troughs for flaming gasoline so that the crew were literally fried in the tank as on a flaming griddle. Here is a startling example of the failure to estimate the conditions under which war equipment must operate.

Importance of Standards

Another fundamental policy in rearmament procedure is the establishment in advance of war of standards of performance. Artillery ammunition is successful in proportion to its standardization. The propellents, detonators and rupturing charges, the accuracy of the fuses are all fundamental factors in assuring predominance with artillery fire. Erratic fire with the 75 mm. gun at 15,000 yards is far less effective as a military weapon than carefully standardized and accurate ammunition at 7,500 yards.

Tell a soldier the limits of his weapon and he will find ways to fight with it successfully. But if you give him ammunition that will range all the way from maximum efficiency to muzzle burst shots, you will ruin his morale, wreck his material and defeat both his tactics and his strategy.

Please note the statement that the standardization must not be so theoretical and refined that it can not be met in quantity production by workers in ordinary shops. The thing that impeded our World War production was the peace time requirements by Regular Army officers of impossible and unnecessary standards of perfection, because they had not designed ammunition and weapons with an eye to their production elsewhere than according to slow peace time methods in government arsenals where workmen of the highest skill were supervised by Regular Army experts.

Your policy must be to have standards and specifications that civilian shops can meet. Then when needed the equipment will be standard in performance in the field without irregularities and surprises. Included in this policy is the elimination of over-refinement of both design and performance. Explosives, gases, gas masks, artillery and small arms, ammunition and all the countless implements of war must meet the average run of conditions. You would not need the performance of a mountain gun in an anti-tank weapon. An 81 mm. trench mortar is of no use to troops if its ammunition is so heavy that it is suicide to try to get it to the gun. Mortars are weapons that travel with the infantry, close up to the front line. It makes no difference to the men trying to serve such a weapon that it may have an extra 500 yards of range if they will be mowed down trying to get ammunition to it.

The art of preparing for war and supplying arms involves major policies as fundamental as those controlling the success of any other form of industrial enterprise. The nation that has the managerial ability and business brains to analyze these problems and establish the correct policies is the nation that wins the war. We retrieved the disastrous mistakes in the last war due to our failure to observe these rules only because the Allies protected us until we learned better how to manage for ourselves.

Priceless Rules for Success

The first and last rule is this: Make the best available equipment at once and continue to make it until better equipment can be designed and put into production of equal or greater quantity. This is the priceless rule for war-time success. It is just another way of saying that it is more important to have industrial capacity well trained on standard designs than to have a few pieces of equipment that have the world's record for performance, but which are so specialized that you will never get enough of them in the field in time to win a war.

Chemical Preparedness

How the Chemical Warfare Service and otherbranches of the U. S. Army have organized their procurement programs to aid industry in meeting governmental requirements with minimum of duplication and red tape.

THE AUTHOR left Carnegie Institute of Technology, where he was a student in Chemical Engineering, in June 1917, to enter the War Gas Investigation Division of the U. S. Bureau of Mines. When the Chemical Warfare Service was organized in 1917, he was commissioned as First Lieutenant and became Chief of the Department of Toxicology and also Assistant Chief of Medical Research, serving in this capacity until 1929. After two years of field service in the Canal Zone, Captain Kuhn returned as Executive Officer of the Chicago Chemical Warfare Procurement District and was active there for four years until sent back to the Canal Zone to command the First Separate Chemical Company. Since late 1938, he has been Executive Officer of the New York Procurement District—Editor.

Squad firing chemical mortar of gas shells

CAPT. HARRY A. KUHN

Chemical Warfare Service, Executive Officer, New York Chemical Warfare Procurement District

OUR MILITARY POLICY in the United States has always been based on a small Regular Army backed by the man power and industrial resources of the country. However, in every great emergency, mobilization of man power has proceeded faster than our industry could produce the items of military equipment needed to make an efficient fighting force.

Much has appeared in the press in recent months regarding rearmament and the need for preparedness. That this is not a new subject is apparent from the following extract from a letter written at Fort Richmond, Harbor of New York, August 11, 1856, by Colonel Richard Delafield, Engineers, to the Honorable Jefferson Davis, then War Secretary:

> Our resources are unquestionably great, and equal to those of several of the powers of Europe combined, but our preparation in material, equipment, knowledge of the art of war, and other means of defense, is as limited and inefficient, as theirs is powerful and always ready.
>
> As a nation, other than in resources and general intelligence of our people, we are without the elements of military knowledge and efficiency for sudden emergency; while no nation on earth can more certainly put itself in a condition to set any hostile force at defiance.
>
> Viewing the subject in all its bearings, I am more impressed than ever with our comparative want of preparation and military knowledge in the country, and that the Secretary of War will do a great good service to the nation by increasing the material and munitions, means of defense, and the diffusion of military information in every possible way that our institutions will permit, without creating any more of a standing army than the growth of the country calls for, preparatory to that great struggle which sooner or later may be forced upon us, and to resist which, with our present means, we are comparatively unprepared. (Senate Executive Document No. 9, First Session, 36th Congress, 1860.)

Some sixty years later, in May, 1919, the Honorable Benedict Crowell, Assistant Secretary of War and Director of Munitions, reported to the Secretary of War that, "When the war touched us our strategical equipment included plans ready drawn for the mobilization of men. There were also certain plans for the training of new troops. It is worthy of note, however, that this equipment included no plan for the equally important and equally necessary mobilization of industry and production of munitions, which proved to be the most difficult phase of the actual preparation for war. The experience of 1917 and 1918 was a lesson in the time it takes to determine types, create designs, provide facilities, and establish manufacture." (America's Munitions 1917-18.)

Since 1920 the War Department has had two major planning organizations, the General or Military Staff under the Chief of Staff, and the Industrial or Business Staff under the Assistant Secretary of War. The Assistant Secretary directs one of the largest business organizations in the United States. During the past year it made over one million purchases, including equipment and supplies for improvement of rivers and harbors, control of floods, the Civilian Conservation Corps, as well as military purchases, totaling over $389,000,000. However, the most important function of the Assistant Secretary of War is to plan for the

Different Types of Gas Masks

Top Row, left to right: U. S. Navy mark I Mask; U. S. Navy mark II Mask; U. S. CE Mask; U. S. RFR Mask; U. S. AT Mask; U. S. RT Mask; U. S. Model 1919 Mask.
Middle Row, left to right: British Black Veil Mask; British PH Helmet; British BR Mask; French M2 Mask; French Artillery Mask; French ARS Mask.
Bottom Row, left to right: German Mask; Russian Mask; Italian Mask; British Motor Corps Mask; U. S. Rear Area Mask; U. S. Connell Mask.

production of the supplies and equipment needed by our Army in war.

Peace-time purchases of the War Department are usually of a commercial item or involve limited production. War-time purchases will include over one thousand essential items which have no commercial counterpart. They will involve production of items in vast quantities which up to the present have never been made excepting in a limited manner in an Arsenal or which may exist now only as a "pilot model." When you realize the time necessary to "tool up" to produce a new model in your factory or the time necessary to go from small scale to a large scale plant, and further that in war, time is precious, it is apparent how important are the present plans to mobilize and prepare industry for national defense.

The actual procurement and specific planning of supplies for the Army is accomplished by the several supply Arms and Services which are charged with that duty by law. The Quartermaster Corps, besides making its own procurements, is responsible for obtaining all supplies of a commercial nature which are common to two or more services. Special and technical articles are procured by the technical arms and services responsible for such articles —Air Corps, Chemical Warfare Service, Engineer Corps, Medical Department, Ordnance Department, Signal Corps and, to a minor degree, Coast Artillery Corps. Certain items required by the Navy are procured by the Army, but the Navy plans emergency production along lines similar to those about to be described.

When the procurement planning activities of the Assistant Secretary of War were first organized, shortly after 1920, it became apparent that the officers of the Army engaged in this work needed special training, and the present system of schooling was established. Each year a limited number of selected officers are detailed as students at the Harvard Business School of Administration to take a two year course in industrial management. In addition, the Army Industrial College was established, and here each year about fifty selected officers of the Army, Navy and Marine Corps are given ten months of intensive training in subjects pertinent to procurement planning. Graduates of these schools furnish the Army and the Navy industrial staffs.

The organization of the Chemical Warfare Service for procurement planning is similar to that of the other supply branches of the Army. This consists of a central organization in the Office of the Chief of the Chemical Warfare Service and a number of field or district organizations. At present there are District Headquarters at Boston, New York, Pittsburgh, Chicago and San Francisco. The district organizations are the direct contacts with industry in planning and in time of war will become the decentralized purchasing agencies of the Chemical Warfare Service in executing their plans.

The organization of the New York Chemical Warfare Procurement District is similar to that of the other districts and consists of a civilian Chief[1], and Advisory Board[2] and a war organization of qualified Reserve Officers. The Chemical Warfare Service officer detailed as Executive Officer makes the contacts with industry and handles the confidential industrial data essential to accurate planning.

The basis for procurement planning is the War Department Protective Mobilization Plan, which establishes the rate at which troops will be mobilized in an emergency, their organization and also their equipment. The requirements computed from this basic plan establish for industry *what* the Army needs, *how many* and *when*. *Where* and *how* to make the item at the desired rate is the job of industry.

The procurement plans of the War Department may be regarded as aids to industry in accomplishing its mission in the National Defense. Before an item is adopted as a standard for military use, the detailed drawings and specifications are circulated by the District Headquarters to suitable industrial concerns for their comments and recommendations regarding clarity of language and suitability of the item for mass production. These approved drawings and specifications are aids.

The next major step in planning is the selection of the plants suitable for production of the item. The allocation to a Service of a plant is controlled by the Assistant Secretary of War. This is essential to prevent more than one Service planning to use the same production capacity of

[1] Chemical Warfare District Chiefs:
Boston—Charles F. Adams, President and Director, Union Trust Co.
New York—Edwin M. Allen, President, Mathieson Alkali Works, Inc.
Pittsburgh—Dr. Wm. O'N. Sherman, Chief Surgeon, Carnegie-Illinois Steel Corporation.
Chicago—George B. Dryden, President, Dryden Rubber Co.
San Francisco — William H. Berg, President, Standard Oil Co. of California.

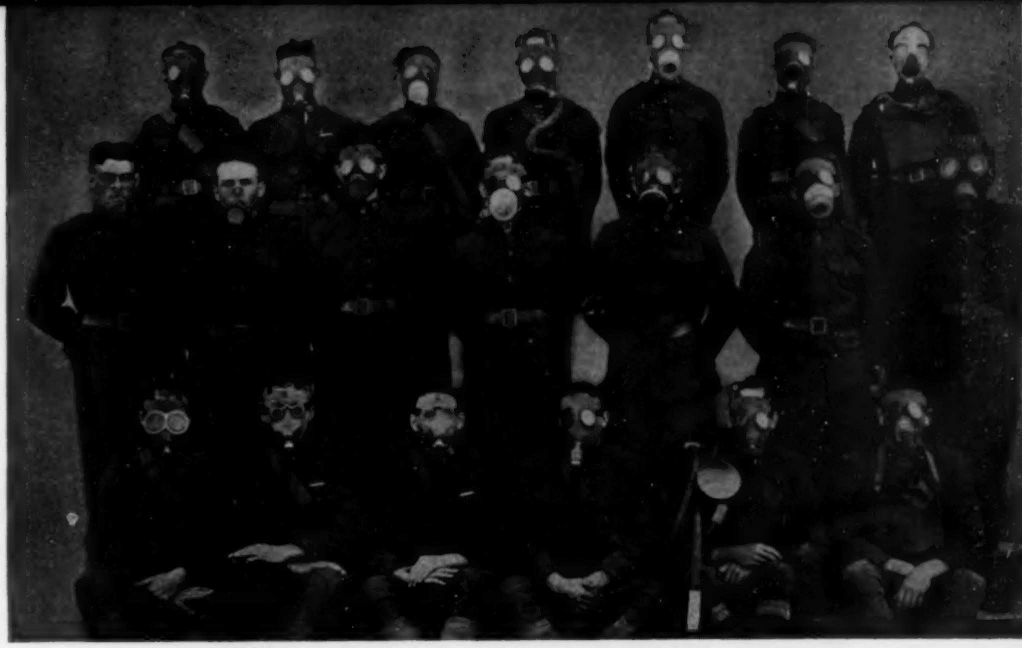
[2] Advisory Board, New York C. W. Procurement District:
William F. Barrett, Chairman Board of Directors, Carbide & Carbon Chemicals Corp.
Frank A. Howard, President, Standard Oil Development Co.
Sidney D. Kirkpatrick, Editor, *Chemical & Metallurgical Engineering.*
Dr. W. S. Landis, Vice-President, American Cyanamid Co.
J. H. Manning, President, Ulen & Co.
Chas. S. Munson, President, Air Reduction Co.
W. W. Finley, Jr., Freight Traffic Mgr., Pennsylvania Railroad.
E. G. Robinson, Gen. Mgr., Organic Chemical, Dept., E. I. duPont de Nemours & Co.
Herbert E. Smith, Vice-President, U. S. Rubber Co.

any plant. The request for allocation of a certain plant having been approved, the District Executive Officer makes a detailed survey of the plant and secures information regarding current production, machinery and equipment, labor, power and fuel requirements, transportation facilities and estimates on production capacity for the desired item. Possible "bottlenecks" in production, the necessary conversion or expansion of existing equipment, sources of supply of intermediates, etc., are investigated. Several possible sources of each essential item required are surveyed in each District and from the data thus secured and evaluated, the requirements are apportioned to each District. As an uninterrupted supply is necessary, reliance is not placed in a single source or area — invasion, air raids or sabotage might cripple or eliminate a supply when most needed.

Considering the available concerns from the viewpoints of safe location, sources of raw materials, transportation, labor, the necessary construction or conversion of equipment, plant hazards, public danger, production efficiency, etc., the District finally places a production schedule with a concern. This schedule, when accepted by the concern, states that if called upon to do so, it can produce the item at a certain rate per month. With this schedule, the concern is furnished the necessary drawings, specifications and in some cases, production data or manufacturing procedure if the item has been manufactured at a Government Arsenal.

Where the concern can not produce the item in the time and quantity required without expansion, a factory plan may be required. This is prepared by the District on information furnished by the facility. In some cases, such plans are comparatively simple, involving rearrangement of equipment or the listing of additional equipment, together with the preferred sources. In other cases, they may be quite extensive, involving construction of additions to existing plant. Due to lack of personnel, few of this latter type have been completed.

The chemicals required by the Chemical Warfare Service, raw, intermediate or finished, do not offer as much difficulty as do some of the related items required. For example, there are approximately sixty separate parts of the gas mask which must be assembled into the complete mask. These include rubber parts, die castings, fabrics, metal stampings, lenses and filter, as well as the chemicals. The production of these parts involves making a large number of dies, special tools, special equipment, jigs, gages, etc. The enormous number of gas masks required for individual protection in time of war makes it a most critical item of procurement planning.



Development of the gas mask in the United States

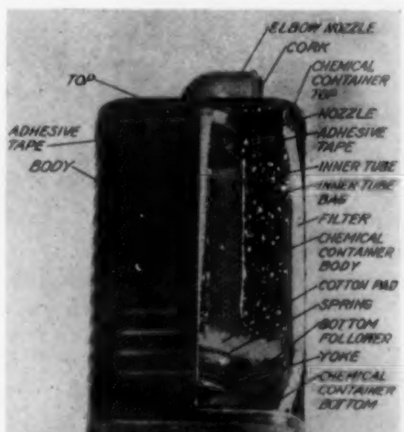
Top Row, left to right: Mask 1-1-2; Mask 3-3-2; ND Mask 1922 type; McBride Mask, type A; McBride Mask, type B; British Mask, 1921 type.
Middle Row, left to right: NS Mask, Model A; NS Mask, Model B; NS Mask, Model C; NS Mask, Model D; NS Mask, Model E; NS Mask, Model F; German Mask Head Wound.
Bottom Row, left to right: Binocular Mask, Model A; Binocular Mask, Mode B; Binocular Mask, Model C; Aviation Mask; Gasoline Mask; Infantry Board Mask.

Among the other Chemical Warfare items which require planning are special chemical engineering equipment; bulk containers, such as ton containers, heavy and light cylinders, drums; gas alarms; chemical mortars and projectors; collective protectors, and special training equipment. Of the items required by the Chemical Warfare Service, approximately 80 per cent are noncommercial in character and involve the preparation of approximately 700 specifications with pertinent drawings.

Within the past few years, limited appropriations have been made for the purchase of jigs, dies, molds, fixtures, gages, etc., for the purpose of acquiring in peace time such manufacturing and inspection aids as would be needed to speed up the manufacturing and procurement program in the event of emergency. The amount has been sufficient to supply only a fraction of the deficiency along this line.

Until the present year, procurement planning has of necessity stopped with the selection of a plant to produce a certain item. The last session of Congress authorized the President to take the next step in procurement planning — that of placing an educational order in plants in order that production might actually be started on a few of the most essential items. The total appropriation for this purpose was $2,000,000 and one of the six most important non-commercial items selected for initial orders was the gas mask. It is probable that by the time this article appears in print, one of the plants already selected to produce gas masks in an emergency will have been authorized to put its program in operation in a limited way.

Sectional view of modern gas mask canister



Instrument Users and Makers Meet

Ten papers covering a broad range of applications of measuring and controlling instruments in the process industries were presented and discussed at a well-attended open meeting at Carnegie Tech.

WITH A TOTAL REGISTRATION of 134, including engineers from both the process industries and the instrument manufacturing companies, a conference on Instrumentation in the Process Industries was held at Carnegie Institute of Technology, in Pittsburgh, on March 2 and 3. Sponsored by the Institute's Department of Chemical Engineering and arranged by Prof. C. C. Monrad in cooperation with Editor M. F. Béhar of *Instruments* Magazine, the two-day session provided ten valuable papers and much worthwhile discussion. In addition, several instrument manufacturers cooperated in an exhibition of instruments which was held concurrently at the Institute.

Key paper of the conference was one on the general principles of instrumentation, by Messrs. C. S. Draper and G. V. Schliestett, of the Department of Aeronautical Engineering, Massachusetts Institute of Technology. Prof. Draper has developed a mathematical technique for the analysis of instruments of all types, which, in the discussion, was described by Mr. Béhar as being an epoch-making, pioneering approach to the problem. The analysis applies equally to both the statics and dynamics of instruments.

Messrs. H. W. Diamond and N. E. Berry, of the Diamond Crystal Salt Division of General Foods Corp., St. Clair, Mich., described in considerable detail a number of ingenious controls employed by their company in the production of salt. Perhaps the most interesting is a salt drying system in which the use of control instruments saves their cost in steam every 12 months. The method is to maintain the temperature of the salt leaving the dryer at about 210 deg. F. by varying the speed of the fan which provides the heating air. The temperature controller automatically cuts resistances in and out of the armature circuit of the variable speed d.-c. motor which drives the fan. The authors also described the application of flow controllers to the Alberger and the interconnected triple-effect evaporator plants that are used for the evaporation of the salt brine. Since excess steam from the Alberger plant is used to heat the triple-effect plant, an interesting system of controls is required to take care of any excess or defficiency of steam that may be available for the evaporators.

More discussion than that aroused by any other paper followed the presentation by W. K. McCoy, instrument engineer of the Gulf Oil Co., Pittsburgh, of his paper on some of the problems of instrumentation that are met in the oil industry. He confined his remarks largely to the limitations of the instruments themselves and urged the instrument manufacturers to develop simpler and less expensive instruments of greater reliability. The paper aroused a spirited defense from representatives of the instrument industry.

Second of the three papers given by oil company engineers was that prepared by R. L. Rude and Colin Barnes, of the British American Oil Co., Ltd., and the University of Toronto, respectively. Mr. Rude presented the paper, which dealt with the control of cracking equipment in response to the yield per pass and to variations in density. Owing to the fact that, in petroleum processing, progressive physical and chemical changes take place, the authors found that variation in density values is a more sensitive indication of the degree of heating of the fluid than is temperature. This follows because cracking depends both on temperature and on time. The method employed is to use a series of orifices at appropriate points in the cracking system from which, by means of differential meters and electrical bridges, it is possible to make automatic electrical computations of the density variation, the time of transit, the yield per pass, and at the same time control the fuel fired to the heating and conversion parts of the cracking furnace.

A paper dealing with the extent to which instruments are employed in the soap industry was delivered by C. T. Atwood, Lever Brothers Co., Cambridge, Mass. The author pointed out that operations in soap manufacture are still to a large extent carried out in batches, so that automatic control is either of relatively simple type, or not used. Instead, manual control with the assistance of laboratory analysis and of instruments is chiefly employed.

The third oil industry paper was presented on the second day of the conference by G. C. Thrift, instrument engineer of the Texas Co., New York, whose topic was instrumentation in the solvent dewaxing process. The instruments used are mostly standard. Many level controllers are required, which are generally of the wide-range type. The most important recorded temperatures are measured with resistance thermometers.

A brief description of the principal instrument applications in the by-product coke plant of the Carnegie-Illinois Steel Corp., was presented by F. J. Nuttall. Unfortunately it was not released for publication.

An extremely complete description of the use of instruments in the electric furnace phosphoric acid plant of the Tennessee Valley Authority was given by J. N. Junkins, who demonstrated that an excellent job has been done. Because of the research nature of the T.V.A. work, the installation is somewhat over-instrumented in comparison with commercial plants. The instrumentation will again be described in a paper to be presented before the A.I.Ch.E.

A quick survey a broad range of electrical instruments and their uses in the process industries was given by E. S. Lee of the General Electric Co., Schenectady, N. Y. The instruments mentioned were so numerous that no summary is possible here. Particular attention, however, was given to the Hardy spectro-photometer, the electrical thickness gage, the dew-point potentiometer, the integrating photoelectric exposure meter, and photoelectric weft straighteners.

A brief description of an important trend in education along instrument lines was presented by C. B. Cochran, instrument engineer of Westvaco Chlorine Products Co., South Charleston, W. Va., whose paper described the 24-weeks' course which he has been presenting for instrument mechanics of the Kanawha Valley in the Charleston Evening Trade School.

Respirators for Chemical Safety

As an authority on industrial respiratory protection, and as a reserve officer actively identified with the Chemical Warfare Service, U.S.A., Mr. Davis is well qualified to discuss the guarding of workers against the gases and dusts encountered in chemical process industries. Care of gas masks will be treated in a later article.

F. RUTLEDGE DAVIS

President
Davis Emergency Equipment Co.
New York, N. Y.

THE LIST of gases, vapors, fumes, and dusts from which workers in various branches of the chemical industry may require respiratory protection is an exceedingly long one, as it comprises many of the products made by the industry. For practical purposes, however, the entire list can be reduced to a small number of types, depending on their chemical characteristics, as shown in the accompanying table.

To protect industrial workers from harmful concentrations of these substances, several different kinds of respirator are used. (In accordance with recommendations of the U. S. Bureau of Mines, the name "respirator" is now being applied to all devices that protect the respiratory tract, whether from gas or from dust.) The principal types of respirators include the chemical filter respirator—commonly called the "canister-type gas mask"; the supplied-air respirator, to which air is supplied through a hose from an uncontaminated source; and the mechanical filter respirator for protection against dusts, smokes and fumes.

Gas Protection

The concentration of a noxious gas that renders air unsafe to breathe varies widely with its physiological effect. From this standpoint, noxious gases and vapors are classified as simple asphyxiants; chemical asphyxiants; irritants; anesthetics; and volatile poisons.

Simple Asphyxiants—When air is diluted with a non-toxic, non-flammable gas, such as nitrogen, it will support combustion and can be safely breathed until its oxygen content falls from its normal value of 20 per cent by volume to about 16 per cent. With further dilution, a candle flame will be extinguished and persons breathing the air will begin to feel the first symptoms of distress due to the deficiency of oxygen. This means that a gas-air mixture can contain as much as 24 per cent of an added harmless gas and still be safe to breathe for a short time; but with higher concentrations, it becomes dangerous.

To determine whether the air in a tank, manhole, or other inclosed space contains enough oxygen to support life, a special form of the well-known miner's safety lamp is widely used. The wick of the lamp is lighted, and some of the mixture being tested is pumped into the combustion chamber by means of a length of tubing carrying an aspirator bulb. If the flame continues to burn normally (and the air does not contain a toxic gas, such as carbon monoxide), the air is safe. But if the flame goes out, no one should be permitted to enter the inclosure without proper protection.

Noxious Gases and Vapors

Type	Description
Simple asphyxiants	Physiologically harmless gases, like N, H, He, CO_2, CH_4, which may cause oxygen deficiency if present in the atmosphere in quantities.
Acid gases	Those commonly encountered include: HCl, SO_2, H_2S, nitrous fumes, and HCN. Cl and Br are also included in this group.
Alkaline gases	Ammonia is the only member of this group.
Organic vapors	A very large group including the alcohols, ethers, aldehydes, etc., gasoline and other petroleum vapors; benzene and its derivatives; tetraethyl lead, CS_2, and many others.
Carbon monoxide	This gas does not fit into any of the above groups, but, being very common and highly toxic, requires special consideration.

Solids and Liquids

(Harmful when suspended in the air)

Dusts	Mechanically generated, usually by disintegrating solids, as in mining, quarrying, grinding, crushing, etc.
Fumes	Small particles of the oxides, or other compounds, of various metals, such as Pb, Hg, Mn, Cu, Cd, Zn, etc., usually formed by their combustion.
Mists	Consisting of small droplets of liquids, as formed in chromium plating, spray-coating of paint and lacquer, etc.

Chemical Asphyxiants—In this class are placed the two highly toxic gases, carbon monoxide and hydrocyanic acid. The first asphyxiates by preventing the blood from carrying oxygen; the second, by preventing the tissues from using oxygen. For carbon monoxide, the concentration considered safe for exposures of from one-half hour to an hour is from 600 to 700 parts per million; for hydrocyanic acid, from 50 to 60 parts per million. (All figures for gas concentrations are from Henderson and Haggard, "Noxious Gases," Chemical Catalog Co., 1927.) Greater concentrations of either are exceedingly dangerous and should not be entered without respirators.

Several different instruments are available for making field tests of carbon monoxide. In one of the simplest types, use is made of an indicator consisting of a small ampoule containing a solution of palladium chloride wrapped in cotton. To use, the ampoule is crushed between the fingers so that the solution saturates the cotton. The indicator is then placed inside a glass receptacle in which the gas-air mixture being tested is pumped. If carbon monoxide is present, the indicator will darken, the depth of the color depending on the concentration of the gas present. Comparison with a color card gives the approximate concentration of carbon monoxide. Various sampling devices are also available, as well as an indicator which registers the percentage of the carbon monoxide on a meter.

No indicator is needed with hydrocyanic acid, as it betrays its presence by its characteristic odor. No one, unprotected, should ever enter an atmosphere containing the slightest traces of this gas. Even with a respirator of the proper type, no one should enter atmospheres containing over 1 per cent, since this gas will poison through skin absorption. If it is absolutely necessary to enter higher concentrations, every part of the body must be covered with gas-tight rubber

garments and the hair must be rendered non-absorbent by a thick coating of vaseline.

Irritants—In this group are such gases as ammonia, hydrochloric acid, sulphur dioxide, chlorine, and phosgene. They attack the surface tissues of the respiratory tract and cause injury and death by inducing acute inflammation of the air passages of the lungs. No special equipment is ordinarily required for detecting the presence of irritants in the air, since the human nose is usually sensitive enough for this purpose. No one without a respirator will willingly enter, or remain in, an atmosphere containing more than 500 parts per million of ammonia or more than 50 parts per million of hydrochloric acid gas. There have, however, been cases where persons, unfamiliar with the nature of chlorine or nitrous fumes, have inhaled fatal concentrations without being aware of their danger.

Anesthetics—A very large number of organic vapors have anesthetic properties and many have irritating or other toxic properties as well.

Gasoline is, physiologically, one of the least harmful of this group of gases, but it is stated that a concentration of its vapors of 1.1 per cent is dangerous for even a short exposure and that a concentration of 2.4 per cent will prove rapidly fatal. The generally accepted figure for the maximum gasoline-vapor concentration that should be inhaled without a respirator is 0.2 per cent, or 2,000 parts per million.

Most of the organic anesthetic vapors are flammable and when they are mixed with air the mixture may be not only toxic but flammable or explosive also. The degree of flammability of such mixtures can be measured by several different instruments. Mixtures giving readings of more than 20 per cent of the lower explosive limit should be assumed to be both flammable and unsafe to breathe.

Volatile Poisons—Included in this group are the true poisons such as mercury, lead, phosphorus, arsenic, phosphene, arsine, tetraethyl lead, nickel carbonyl, and cacodyl. No one, of course, should ever breathe air containing the slightest traces of any of these substances.

Hydrogen sulphide is also included in this group because in large amounts it paralyzes the nervous system. The safe limit of concentration for this gas is placed at 0.01 per cent. As it is a common chemical reagent, chemists sometimes become careless in its use, but it should never be forgotten that it may be as deadly as hydrocyanic acid. A man inhaling a high concentration of either drops dead.

For constant exposure to these various substances the figures given are in most cases much too high for safety. Many of these gases are harmful if inhaled over long periods at very low concentrations. The air in which work is normally carried on must be kept sufficiently free from contamination to protect the workers from any degree of chronic poisoning.

Chemical Filter Respirators

The chemical filter respirator (or "gas mask") is made in several different styles, but the one ordinarily used in the chemical industry consists of a tightly-fitting rubber face piece, or mask, which is connected by means of a flexible tube to a canister containing chemicals which have the property of absorbing one or more noxious gases. The canister is worn strapped to the chest, side, or back.

Workers wearing hose masks, leaving an oil tank; except in special circumstances life lines are required

On inhaling, the wearer of the mask draws contaminated air from the surrounding atmosphere through the canister, where it is purified. On exhaling, the vitiated air passes out through an exhale valve, a check valve preventing its return into the tube and canister.

This type of respirator has three important limitations: (1) As the air supply is drawn from the surrounding atmosphere, the respirator cannot be used in atmospheres deficient in oxygen. (2) The capacities of the chemical filters are limited and the respirator must not be used in atmospheres containing more than 5 per cent of organic vapors, 3 per cent of ammonia, or 2 per cent of acid gases. (For hydrocyanic acid, as has already been pointed out, it is dangerous to enter concentrations greater than 1 per cent without complete protection for the entire body.) (3) The useful life of the canister is limited, so that this type of respirator is unsuited for use when the wearer must remain in the toxic atmosphere for long periods.

These limitations indicate that chemical filter respirators are best adapted for use in the open air or in large inclosures where there is plenty of oxygen and the noxious gases will be well diluted. For working in small inclosures, such as tanks, vaults, etc., where the atmosphere may be deficient in oxygen or the concentration of the noxious gases high, the hose mask type of supplied-air respirator (to be described later) is generally indicated.

Canister-type respirator with 2,000 cc. canister, worn while gaging a sour-crude tank for hydrogen sulphide protection

Obviously, the filter used with the chemical filter respirator must be adapted to the gas it is to absorb. It so happens, however, that a very few types of chemical filter will handle the great majority of noxious gases encountered in industry. These filters are supplied in canisters that are standardized as to coloring and range in capacity from 300cc. to 2,000cc.

Canisters

For protection against	Color of canister
Acid gases, including H_2S and Cl	White
HCN	White, with green stripe
Ammonia	Green
Organic vapors, including the organo-metallic compounds	Black
Carbon monoxide	Blue
Organic vapors and acid gases	Yellow
Organic vapors, acid gases, and ammonia	Brown
"All Service" (all above classes of gases)	Red

Several different chemicals are usable as chemical filters, but those commonly employed are: soda-lime for acid gases; an organic acid, copper sulphate, or silica gel for ammonia; activated carbon for organic vapors; and "hopcalite" for carbon monoxide. This latter substance consists of a mixture of metallic oxides which oxidizes carbon monoxide catalytically to the harmless carbon dioxide.

The "combination" canisters contain two or more kinds of filters. They are of special value in military and fire department service but some chemical industries also find use for them. It is, of course, uneconomical to use combination filters where single filters can be used.

Any of these canisters can be supplied with filter pads to provide protection against smoke and dust.

Supplied-Air Respirators

With supplied-air respirators, the inhaled air is not drawn from the surrounding atmosphere, as is the case with chemical filter respirators, but is supplied through a hose from an uncontaminated source. There are several different types of supplied-air respirators, but the one chiefly used by the chemical industry is the *hose mask*. This type is suitable for use in atmospheres that are deficient in oxygen or that contain high concentrations of dust or of any of the noxious gases that are safe to enter without skin protection.

The face piece of the hose mask is similar to the face piece of the chemical-filter respirator. Air, from a pure source, is supplied through a 1-in. hose, a hand or motor-operated blower being needed when the hose is more than 25 ft. long. The greatest length of hose permitted by the U. S. Bureau of Mines is 150 ft., because a man can still breathe (although with difficulty) through a 1-in. hose of that length without artificial assistance—and hence can escape from a contaminated atmosphere without removing his mask should his blower fail.

Blowers used with hose masks are of the centrifugal or the positive-pressure (rotary) type. The latter is preferable because it can maintain a positive pressure in the breathing circuit at all times and thus prevent the entrance of contaminated air through unsuspected leaks should the wearer of the mask be engaged in heavy work and make excessive demands on his air supply. It should always be used for hose lengths of over 75 ft.

In departments of chemical plants where workers are at times liable to be exposed to toxic gases, or where tanks or other inclosures containing such gases must be frequently entered for cleaning or other purposes, a permanently installed hose mask system may be desirable, with one or more hose lines, with masks attached, wound on permanently installed reels. Each hose line is attached at its inner end to a hollow drum forming the center of its reel and is supplied with air by a motor-driven positive-pressure blower.

Self-contained one-half hour oxygen breathing apparatus (Mine Safety Appliances Co.)

Bureau of Mines approved mechanical filter respirator for Type A dusts (H. S. Cover)

Somewhat similar to the hose mask is the ***air-line respirator***, developed to protect workers engaged in paint or lacquer spraying, abrasive blasting and other processes involving the use of compressed air. Air is supplied to the face piece through a ½-in. hose from the compressed air system or a positive-pressure blower. (In the former case, a reducing valve, and filters to remove moisture and oil vapors are required; in the latter case, these accessories are not needed.)

As a man by his own efforts cannot draw air through a ½-in. hose, the wearer of a respirator of this type must remove his mask should his air supply fail. Therefore, the air-line respirator is limited to uses where the worker can escape without wearing a respirator if need be.

Where complete independence from a hose line is essential, the *self-contained type of respirator* is used. In this apparatus, the breathing circuit is a closed one. The same air is breathed over and over again, fresh oxygen being supplied, as needed, from a small cylinder of the compressed gas, while the exhaled carbon dioxide is absorbed in a canister containing soda-lime. This type of respirator is widely used in mine rescue work and by fire departments and sometimes finds application in the chemical industry. The outfit is heavy and difficult to maintain in proper working order and should never be used by those who are not thoroughly trained in its use.

Dust and Fume Protection

Mechanical filter respirators use felt, filter paper, cloth and sponge filters and are classified as follows by the U. S. Bureau of Mines:

Type A—For protection against mecanically generated dusts. The filter pads must be capable of freeing the inhaled air from silica dust and ground flint.

Type B—For protection against metal fumes. Although it is similar to Type A, the filter pads must be capable of catching finer particles.

Type C—For protection against the acid mist encountered in chrome plating, paint mists produced by spray guns, and water mists carrying silica dust.

In addition, there are various combination types, such as Types AB, AC, etc., and a Type D which is suitable for all three services. In all types the filter pads used are cleaned or renewed when they become clogged.

Atmospheric Cooling Tower Design

This second of a series of three articles by Mr. Simons presents in detail an empirical method for designing atmospheric water cooling towers. Last month's article discussed cooling tower theory; next month's will facilitate forced draft tower design.

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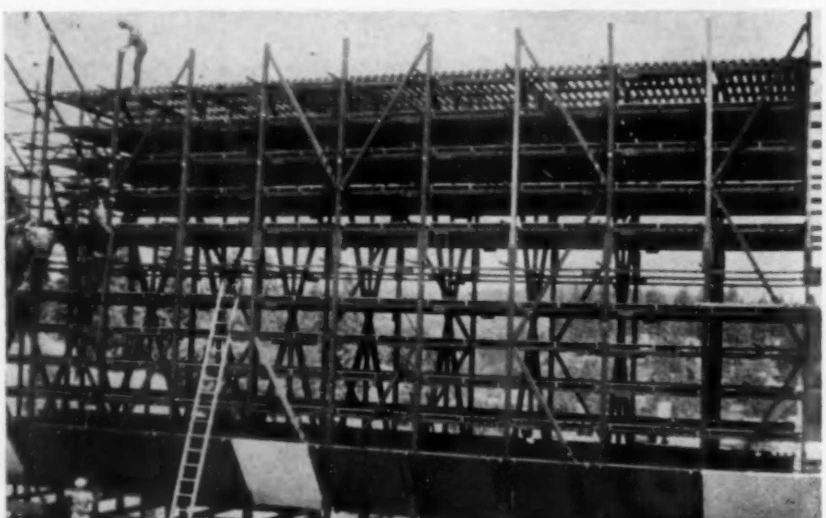
Design and investigation of cooling towers is complicated by the many variables and factors which must be considered. However, scientific and solid methods of investigation are clearing a path over which the feet of the interested may tread with great assurance. The future will offer exact solutions of cooling tower problems to the engineering profession.

The data which are presented below deal with atmospheric, or free-convection, towers in which air movement is accomplished by the wind and by drafts generated during operation. They have been assembled during a number of years. The method of solution should give satisfactory results for the conditions and assumptions which are recognized and specified in the following. The curves and tables have been developed through the use of results obtained from both test and commercial towers. Newly observed results have continually influenced and reshaped previous ideas of operating action.

In the design of a cooling tower according to this method it is necessary to take into consideration the wet-bulb temperature of the air; the temperature of the hot water supplied to the tower and of the cooled water leaving the tower; the water rate; the tower dimensions; and the wind velocity. All of these factors affect the design. Certain of the dimensions are under the control of the designer and must be assumed before the remaining dimensions can be selected in relation to the uncontrollable factors of temperatures, water rate and wind velocity. Four charts and two tables are presented whereby the several variables can be evaluated for the calculations. Chart I portrays the performance of the tower with respect to the wet-bulb and inlet and outlet water temperatures. Chart II supplies a correction for unit water rate; Chart III a factor for dynamic surface dependent on splash deck spacing; and Chart IV, a correction for wind velocity. Table I supplies a factor dependent on the slope of the tower louvers, and Table II determines the maximum tower width in relation to the splash deck spacing. Together with a few tower dimensions more or less standardized by experience, these factors completely determine the design.

As demonstrated in the first article of this series (*Chem. & Met.*, Jan. 1939, p. 83) the thermal operation of a cooling tower is dependent on the entering wet-bulb temperature of the air which circulates through the tower. Chart I shows the basic performance at normal barometric pressure for various wet-bulb temperatures in terms of a factor $C = C_h - C_c$, which is proportional to the cooling surface required to effect a drop in the water temperature from the entering temperature T_h to the exit temperature T_c. The wet-bulb selected for design of a refrigerating installation should be such that it will not be exceeded more than 5 to 8 per cent of the time in summer, while for towers for internal combustion engines, steam turbines, condensing processes, and so on, the design wet-bulb should be chosen with due consideration for conditions and requirements during the peak load season. The chart is based on an assumed wind velocity of 5 miles per hour which is generally the maximum that should be used in design. The C factor is corrected for

Fig. 1—Typical atmospheric cooling tower during construction



the actual design wind velocity chosen, by the use of Chart IV.

Probably the easiest place to go wrong in cooling tower design is in the choice of the proper wet-bulb and wind velocity. (See A.S.H.V.E. "Heating, Ventilating and Air Conditioning Guide" and local weather records for these factors.—Ed.) Precise design methods may be seriously vitiated through incorrect selection of these quantities. For example, as shown by the dashed lines on Chart I, a drop in water temperature of 25 deg. from 105 deg. F., at 70 deg. wet-bulb, gives a C intercept of 9.7. If, however, the water were cooled 25 deg. from 104 deg. at the same wet-bulb, the C value would be 10.5, showing that under these circumstances, a 1-deg. closer approach to the wet-bulb requires 7.2 per cent more effective cooling surface. Furthermore, as will be clear from the shape of the wet-bulb curves, the closer the tower is working to the wet-bulb, the greater the amount of effective surface that must be added for an additional 1-deg. approach to the wet-bulb. Similarly, as appears from Chart IV, a decrease in the wind velocity from 5 miles an hour to 4 increases the V factor from 1.0 to 1.11, thus increasing the required effective surface in this ratio.

If two towers have identical details of construction, but different dimensions of overall size and if each tower is independently exposed to an identical wind of constant velocity, the wind will have different stream patterns about and through the different towers; if the Reynolds' numbers of geometrically similar bodies are unequal, the streamlines themselves are geometrically dissimilar. (Tietjens, "Applied Hydro- and Aeromechanics," 1st ed., pp. 6-9). Furthermore, if a constant wind is assumed, and if the slats of the splash deck of a tower are varied, the stream pattern over the slats is changed, and the rate of heat exchange is also changed (Walker, Lewis, McAdams and Gilliland, "Principles of Chemical Engineering," 3d ed., pp., 109-113, 443-449). In practice, small water loads are cooled by towers which have smaller structural details than towers which operate at high loads. The design basis which is given herein has been evolved from observations covering the size ranges of the commercial field. The mechanics of the empiricism employed has given an approximate recognition to the effects of variations of sizes and shapes. The splash deck slats of the

Nomenclature

- A = Surface efficiency factor (Chart II).
- a = Face of cooling surface element (Surface Key, Fig. 2).
- B = Surface efficiency factor (Chart II).
- b = Face of cooling surface element (Surface Key, Fig. 2).
- C_h = Reading on C Scale corresponding to T_h (Chart I).
- C_c = Reading on C Scale corresponding to T_c (Chart I).
- C = C_h-C_c.
- D = Dynamic surface factor (Chart III). Sq. ft. per (g.p.m.) and (fall of H).
- d = Face of cooling surface element (Surface Key, Fig. 2).
- E = Thickness of splash-deck slats, inches.
- e = Face of cooling surface element (Surface Key, Fig. 2).
- F = Loading, g.p.m. per square foot of active area = Q/LW.
- f = Wetted length of cooling surface element, feet (Surface Key, Fig. 2).
- G = Air velocity through tower, feet per minute (Equation 1).
- g = Wetted portion of louver width, $H/3$ inches.
- H = Vertical distance, center-to-center, of splash decks, inches.
- J = Angle which louver panel makes with the horizontal, degrees.
- K = Heat transfer factor (Equation 2) B.t.u. per min., sq. ft., and in. Hg vapor pressure difference.
- L = Active length of tower, center-to-center of end posts, feet.
- M = Number of typical bays in length L.
- N = Number of splash decks in tower (Equation 4).
- n = Numbers of layers of splash-deck slats in distance H.
- P = Thickness of main posts, inches.
- p = Effective perimeter of cooling surface element, inches.
- Q = Water flow over tower, U. S. gal. per min.
- R = Vertical thickness of longitudinal, horizontal frame tie, inches.
- S = Effective fixed sheet (wetted surface) area, sq. ft. per sq. ft. active area (Table III).
- T_h = Temperature of heated water entering tower, deg. F. (Chart I).
- T_c = Temperature of cooled water leaving tower, deg. F. (Chart I).
- U = Velocity in feet per minute at which wind with velocity of approach of 5 miles per hour leaves tower having louver angle, J (Table I).
- V = Wind factor based on velocity of approach of broadside wind (Chart IV).
- W = Active width of tower, feet.
- Z = Surface efficiency factor for blanketed surface elements (Equation 3).

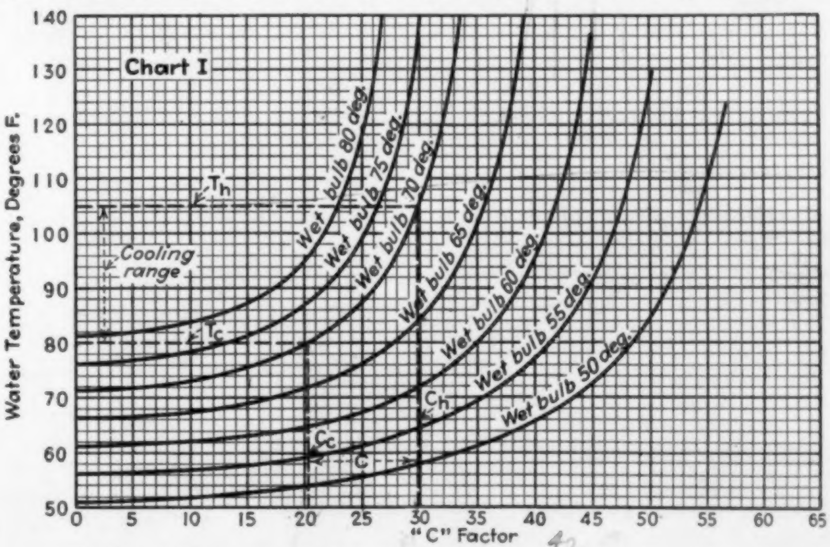
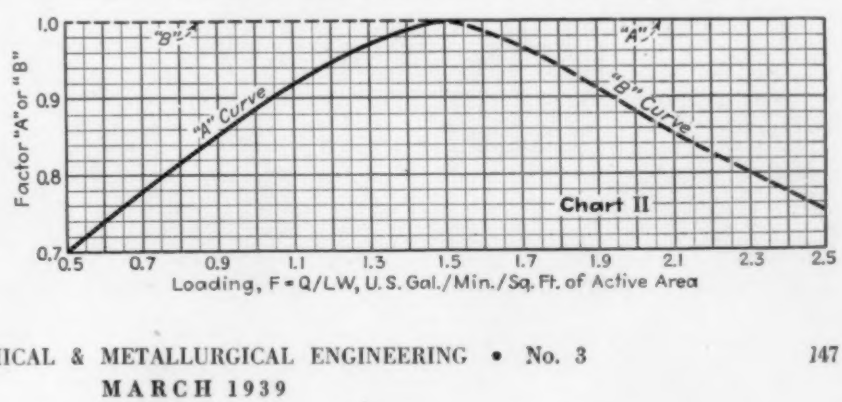


Chart I—Graph showing tower performance under varying air and water conditions

Chart II—Graph for correcting tower calculations for water loading rate



design are rectangular; their greatest thickness should not exceed 1 in., nor be less than ⅜ in.

An atmospheric tower may employ cooling surface of the drop form, the sheet form, or both drop and sheet forms in combination. The common splash-deck tower forms drop surface as the water falls and splashes; the deck slats, slat supports, posts, braces, louvers, etc., act as guiding surfaces over which the water spreads to develop sheet surface.

In Fig. 2 are shown sections of a typical splash-deck tower. The heated water is introduced to the apparatus by means of an appropriate distribution system. The water is spread over the highest deck, flows around the deck slats, then falls from the bottom side of the slats. When the rate of water flow per square foot of active surface (loading concentration, F) is less than that of a certain critical loading, drops will form. The drops appear as bulges in the water film on the lower surfaces of the slats. As the pressure and weight above a bulge increases, the incipient drop increases in size until the surface tension of the water film is no longer sufficient to support the weight of water contained in the film sac. The water of a portion of the bulge is detached and falls as an individual drop. When the critical loading concentration is exceeded, the water leaves the surface film in streams which wave action may eventually develop into drops.

The water which has fallen as drops or streams splashes into spray when it strikes the lower cooling elements of the tower. This impact action also produces a stirring, turbulent action which aids in cooling and in the maintenance and extension of distribution. A reduced loading concentration results in reduced spread of water over the guiding surfaces and factor A (read from the "A" Curve of Chart II) is used to compensate for the reduction in the spread and stirring action which ensues when loadings are decreased. When the value of the loading concentration exceeds that of the critical optimum loading of 1.5 gal. per square foot of active surface, drop formation becomes less effective, and increased resistance to air flow occurs. Factor B (read from the "B" Curve of Chart II) is used to compensate for the decrease in the efficiency of an apparatus caused by increased loadings.

The heat transfer factor of a tower depends upon the actual wind velocity between the decks, which in turn depends upon the velocity of approach and certain tower dimensions, including the angle of the louvers, the tower length, number of bays, deck spacing, thickness of the deck slats and the width against the wind of the main posts and the horizontal frame ties. Table I gives values of U, the velocities with which a 5 mile per hour wind will leave towers with various louver angles, J. Knowing U, the velocity between the decks, G, can be calculated from the equation

$$G = \frac{ULH}{M((L/M)-(P/24))(H-nE-R/2)} \quad (1)$$

Knowing G, the heat transfer factor K can be determined from the equation

$$K = 3.80 + 0.016\,G \quad (2)$$

Once the center-to-center spacing between splash decks has been decided, the maximum acceptable width of the tower decks *down wind* is fixed, as is shown in Table II which gives maximum width values for various deck spacings.

The design of the tower determines how much wetted surface is produced and how much of this surface is effective. The next step in the

Table I—Values of "U" for Various Values of "J"

J, Deg.	U, F.P.M.
40	351
45	340
50	328
55	315
60	301
65	286
70	270
75	252

Table II—Maximum Values of "W" for Various Values of "H"

H, In.	W, Ft.
12	6
18	8
24	10
30	12

Fig. 2—Details of atmospheric cooling tower designed in accompanying text problem

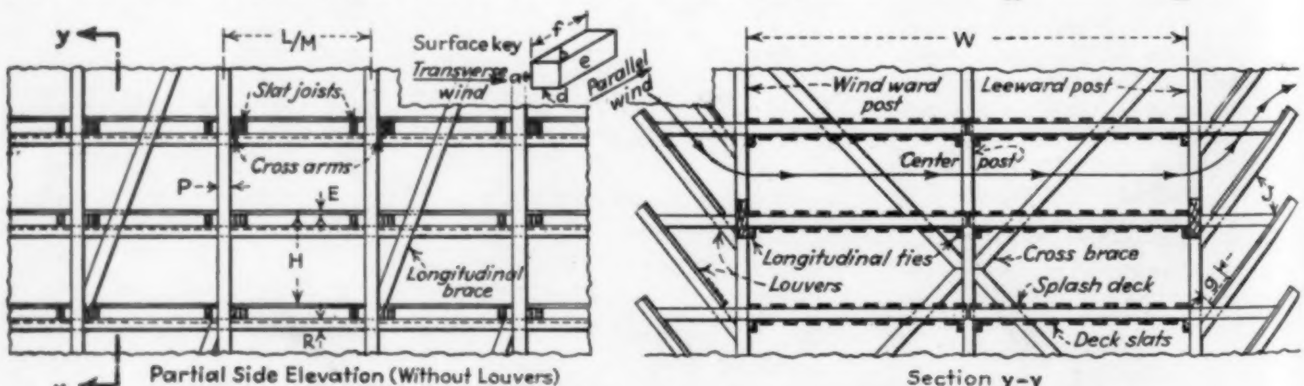
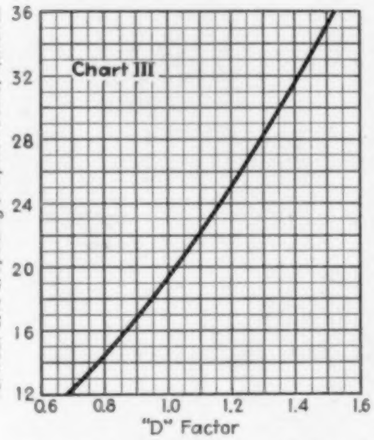


Table III—Tabulated Effective Wetted Surface Calculations for Typical Cooling Tower Design

Member (1)	Number of Pieces (2)	Sectional Dimensions, Inches (3)	Elements of Effective Perimeter,* Inches: Face a (4)	Face b (5)	Face d (6)	Face e (7)	Effective Perimeter,† p (8)	Column (2) Times Column (8) (9)	Wetted Length, f Ft. (10)	Column (9) Times Column (10) (11)
Deck slats	38	¾ × 3⅝	¾ Z = 0.29	3.63	3.63	¾ Z = 0.29	7.84	297.92	3.7	1,102.3
Slat joist	2	1 × 3¾	3¾ Z = 1.46	0	0	3.75	5.21	10.42	6.0	62.5
Slat joist	2	1 × 3¾	3.75	0	0	3.75	7.50	15.00	6.0	90.0
Long. ties	4	1¾ × 2¾	2.75	1.75	1.75	2¾ Z = 1.07	7.32	29.28	4.0	117.1
Cross arms	1	1¾ × 3½	3.50	0	0	3¾ Z = 1.46	4.96	4.96	12.0	59.5
Windward post	1	3¾ × 3¾	0	3.75	3.75	3¾ Z = 1.46	8.96	8.96	2.3	20.6
Leeward post	1	3¾ × 3¾	3.75	3.75	3.75	0	11.25	11.25	2.3	25.9
Center post	1	2¾ × 3¾	3.75	2.75	2.75	3¾ Z = 1.46	10.71	10.71	2.3	24.6
Cross braces	2	3¾ × 3¾	3.75	3.75	3.75	3¾ Z = 1.46	12.71	25.42	3.0	76.3
Long. braces	1	2¾ × 3¾	3.75	2.75	2.75	3¾ Z = 1.46	10.71	10.71	2.4	25.7
Louvers	2	....	....	H/3 = 10	....	....	10.00	20.00	4.0	80.0
Total, Column (11)										1,684.5

* See Surface Key, Fig. 2. † Sum of Columns (4), (5), (6), (7).



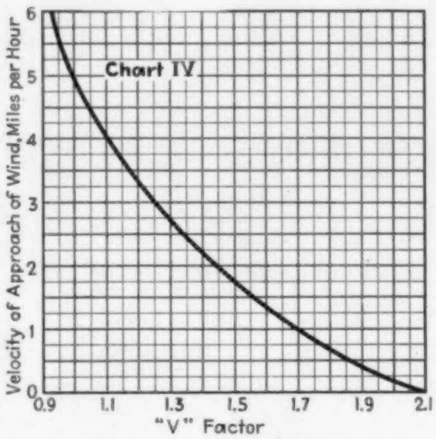


Chart III—Graph for correlating dynamic surface with tower deck spacing
Chart IV—Graph for correcting tower calculations for wind velocity

calculation, then, is actually to determine from the dimensions of the members of the tower the value of S, the unit effective wetted surface per square foot of active cross-section of the tower. This is later carried out in Table III for a typical example, but the principles of this calculation will be discussed at this point, however. Referring to Fig. 2, it will be clear that not all the surfaces will be wetted, and not all will be equally effective, in that some will be blanketed. The effective area of blanketed surfaces is determined by multiplying the actual area by a factor Z which is obtained from the equation

$$Z = 3.80/(3.80 + 0.016\,G) = 3.80/K \quad (3)$$

Both the windward and leeward edges of the splash-deck slats are considered as blanketed and so must be multiplied by Z, as is the case with the adjacent faces of the main cross arms and the slat joists. The exterior faces of the main posts are not considered as being wetted, nor are the edges of the slat joists considered as active surface, since they tend to compensate for the unwetted bearing area of the slats on the slat joists. All horizontal surfaces are considered as fully effective, and their entire areas used. Vertical members and braces are considered as active wetted surfaces along lengths which lie *between* the horizontal members.

It is now possible to determine the number of splash decks required, using the equation

$$N = \frac{32\,(CV/KB) - (LW/2Q)}{(SLWA/Q) + D} \quad (4)$$

Designing a Cooling Tower

It is desired to design a tower for cooling 650 g.p.m. of water from 105 deg. to 80 deg. F., using a design wet-bulb of 70 deg. F. and a maximum wind velocity of 3 miles per hour, broadside. The available foundation space for the tower is 20 x 51 ft. The usual maximum width of 12 ft. will be specified which, with the overhangs of the louvers and the addition of the post widths, will fit into the 20 ft. space. An active length of 44 ft. will be used (when space is unlimited the length must sometimes be determined by trial and error to produce a reasonable height.—Ed.). This length, with the addition of the louvers and posts will not exceed the 51 ft. dimension. The tower will employ bays of 4 ft. width so that 11 bays will be required. The louver angle J will be 50 deg. and the decks will be spaced 30 in. center-to-center. Expressing these specifications in terms of the nomenclature we have $T_h = 105$, $T_c = 80$, $Q = 650$, $W = 12$ ft., $L = 44$ ft., $L/M = 4$, $J = 50$ deg. and $H = 30$ in.

The design is started on the basis of tower action with a wind of 5 miles per hour, broadside to the tower. Hence, from Table I, $U = 328$ ft. per min. E is taken as $\frac{3}{4}$ in., R as $2\frac{3}{4}$ in. and P as $3\frac{1}{4}$ in. Hence, substituting in Equation (1),

$$G = \frac{328 \times 44 \times 30}{11\,(44/11 - 3.75/24)\,(30 - 2 \times 0.75 - 3.75/2)} = 377 \text{ ft. per min.}$$

From Equation (2) $K = 3.80 + (0.016 \times 377) = 9.83$ B.t.u. and from Equation (3) $Z = 3.80/K = 3.80/9.83 = 0.39$. The loading $F = Q/LW = 650/(44 \times 12) = 1.23$ g.p.m. per sq. ft. of active area.

For the design wet-bulb and the inlet and exit water temperatures, Chart I shows (see dashed lines) that $C = C_h - C_c = 29.9 - 20.2 = 9.7$. Chart II shows for a loading of 1.23 g.p.m. that $A = 0.952$ and $B = 1.0$. Chart III gives $D = 1.35$ sq. ft. per gal. for a deck spacing of 30 in. and Chart IV gives a wind velocity correction factor $V = 1.25$ for a wind velocity of 3 miles per hour. The only remaining factor to be determined is S, the unit effective wetted surface.

To calculate S, refer to Table III and to the drawing, Fig. 2. This factor is calculated for a single unit vertical cross sectional area of the tower, including one deck, for a width of one bay, or 4 ft. The "surface key" given on the drawing identifies the surfaces a, b, d, and e which are the surfaces of the various elemental members of the tower, with respect to the wind direction. Note that the wetted width of the louvers is taken as $H/3$. As in Table III each member is examined, its effective perimeter calculated (with blanketed surfaces multiplied by Z) and the effective area determined by multiplying by the wetted length. Note that to save calculation, feet and inches are multiplied together and the sum of all the effective areas is divided by 12 to give $1{,}684.5/12 = 140.3$ sq. ft. of effective wetted surface per panel. The value of S per sq. ft. of active area is then $140.3/(LW/M) = 140.3/48 = 2.92$ sq. ft. per sq. ft. of active area.

Substitution in Equation (4) of the various values determined above gives:

$$N = \frac{\dfrac{32 \times 9.7 \times 1.25}{9.83 \times 1.00} - \dfrac{44 \times 12}{2 \times 650}}{\dfrac{2.92 \times 44 \times 12 \times 0.952}{650} + 1.35} = 10.8 \text{ decks.}$$

Hence, eleven decks will be specified. The total height of the tower will approximate 2.5 times the number of decks plus 5 ft., or 32.5 ft. Distribution may be accomplished in a vertical height of tower equal to $\pm$ 3 ft. If a spray chamber should be used for distribution, the surfaces of several decks would be replaced by spray-drop surface; the number of decks in the tower would be decreased, although the overall height would remain practically unchanged.

If all of the physical characteristics of a tower are known, it is possible to solve Equation (4) for the values of C resulting from the use of various values of V and F. These values of C may be applied to any of the wet-bulb curves of Chart I and the operation of the tower at various wet-bulbs estimated.

Again Ford Shows the Way

Ford Motor Co. engineers have devised a number of important money-saving advances in the art of sheet glass production. One of these, the briquet charging procedure, has stirred quite a controversy over methods forcharging of glass furnaces.

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NEW TECHNOLOGY in the manufacture of glass is causing considerable debate among the engineers of this industry. In fact, the developments at the Twin City plant of the Ford Motor Co. have stirred quite a controversy over methods for charging of the glass furnace. Ford engineers have devised the briquet charging procedure around which this controversy rages; and this same group of technical men has also been responsible for a number of other almost equally important money-saving advances in the art of sheet glass production.

Several outstanding novelties in procedure at the Twin City plant deserve chemical engineering attention:

1. The mining of sandstone directly under the plant as a substitute for purchased glass sand.
2. Briquetting of the mixture before charging into the furnace.
3. Automatic control with push-button operation for every unit of the furnace, from the charging bin to the conveyor at the outlet of the lehrs.
4. Reversal of heating on the basis of pyrometer control instead of mere time control.
5. Close draught control on the products of combustion at the draw tank, for more accurate maintenance of temperature of the glass in the hot sheet between the tank and the bending roll.
6. An adjustable curtain wall at a mid-point in the furnace over the glass tank.
7. New technique for use of vinyl-resin plastics for safety glass.

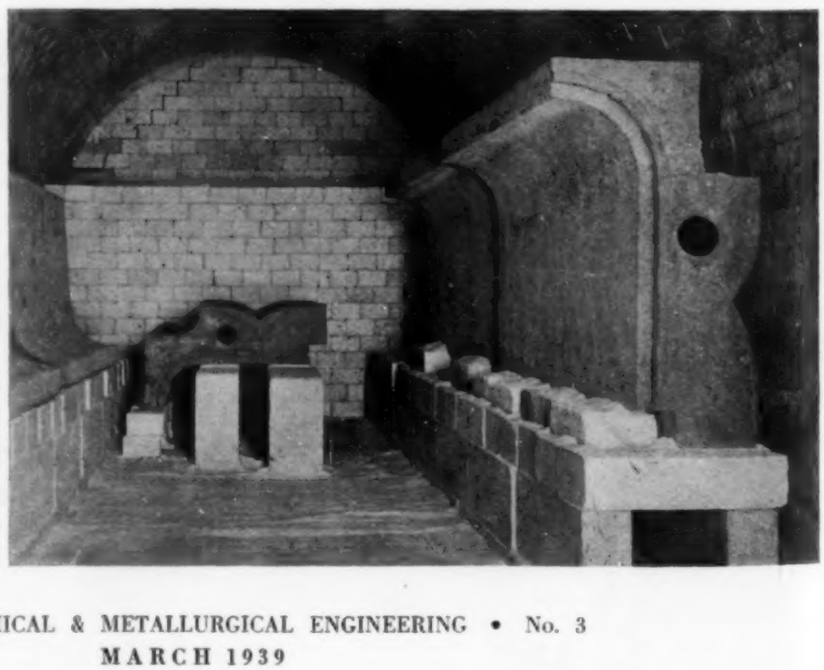
And there are at least a dozen other minor changes in conventional methods which would stir the interest of any specialist in glass making. As a matter of fact, the Ford engineers are upsetting habits in glass making almost as radically as Mr. Ford did automobile manufacture when he established the assembly line. And this new chemical engineering practice is not being arbitrarily injected; it is being superimposed on sound, carefully studied glass-making science.

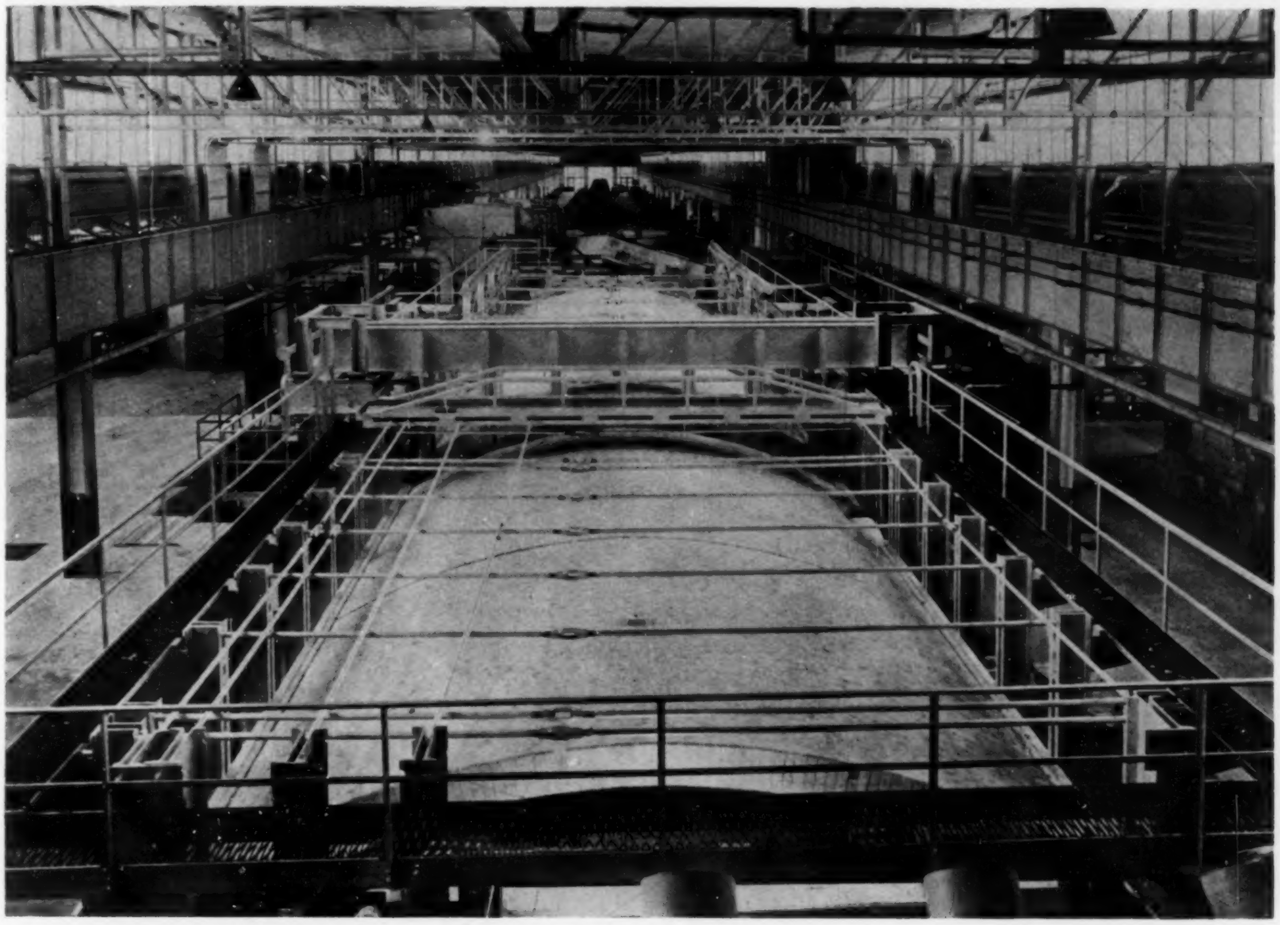
When the Twin City Ford assembly plant was built it was necessary to dig a shaft and tunnel from the upper level at which the main plant is situated down to a point 100 feet lower on the river bank where are located the steam and hydroelectric power stations of the company. Much of this shaft and tunnel went through the typical Minnesota sandstone that forms a thick bed under the limestone, which is the top sedimentary rock of this glaciated area.

The source of the silica of the glass mix is just 105 feet straight down from the furnace itself. At that point the soft sandstone is dug out from long tunnels, giving a product over 99 per cent SiO_2 on a dry solids basis. In fact this sand is too pure. It is necessary to add iron to the furnace batch in order to raise the iron content to that percentage desired in the glass.

Preparation of this sandstone for furnace use involves merely a water washing, to leach out unwanted organic material which has seeped into the sandstone layer through cracks in the supernatant limestone. Therefore, the cost of the dried sand delivered at the mixing belt is less than

Construction view of furnace shown on opposite page. One feature of this furnace is the adjustable curtain wall at a mid-point over the glass tank





Charging end of furnace in the Ford plant, looking toward glass cutting tables. Many revolutionary changes have been incorporated in this furnace which should make it of more than usual interest to chemical engineers using furnaces

only the freight bill on purchased sand would be. And even if the sand mining does not go outside the small acreage owned by the Ford company itself, there is an abundance to supply this glass plant for at least 80 years, the engineers estimate.

Proportioning of the mix for the charge is accomplished through a series of material bins that feed onto a mixing belt through hopper-scale units. This permits accurate control for mixture uniformity. The belt conveyor that runs under these bins carries the powdered material to an elevator which lifts it into a mixing hopper about 20 feet above the operating floor. After completion of the mixing, the material feeds directly from the bottom of the mixing unit into the hopper of a briquetting press. This forms the mix into little pillow-shaped briquets about 2 in. square and nearly $1\frac{1}{2}$ in. thick.

This briquetting press is designed to operate at a pressure of approximately 2,300 lb. per sq. in. The forming rolls, which take the material direct from the feed hopper, rotate at approximately six times per minute, forming 128 briquets per revolution. At the early stages of the briquetting work a small quantity of sodium silicate (water glass) was used as a binder. More recently it was found that hydrated lime would serve this purpose equally well; but water glass is still used as lime is added only as carbonate. The composition of this binder is, of course, taken into account in calculating the composition of the total mixture wanted for the furnace.

The binder represents the only extra cost for material. The capital cost for briquetting press and for briquet-curing and storing units represents the extra overhead. The power required for the briquetting units is practically the only other extra operating cost, because the labor involved in operation is actually a trifle less when briquets are made and charged than the labor requirement would be if the powdered mix were charged without briquetting.

The glass furnace is located in the center of this great automotive factory. The Ford company insistence on clean operation and perfect housekeeping could not tolerate dusty materials-handling at such point. Thus the preparation of the charge for the furnace in briquet form was originally planned primarily to reduce the dustiness of the operation of the glass furnace.

Even if the glass cost a little more when made in a dustless way from a briquetted charge, the company prob-

ably would have made this radical change. But as the use of briquets has been fully developed, the preparation of the material in this form is providing a substantial over-all economy. In fact, this development seems to promise as radical an economy jolt for glass makers as it did a technologic shock to the old-fashion shovel-charging glass-furnace man of yesterday. Here are some of the many factors which favor briquet charging:

(a) A furnace designed for 75 tons of glass a day on the old basis has easily 100 tons capacity with briquet charging.

(b) With briquet charging the glass composition is much more uniform, and a smaller percentage of cullet is made. (The cullet percentage here is less than the old-style glass maker believes to be needed for satisfactory batch mixing.)

(c) The furnace man does not require a high percentage of cullet in his charge to secure satisfactory melting with briquets. Hence the minimum percentage which can be made is the most desirable, as it minimizes the cost for remelting.

(d) With briquet charging the natural gas required per ton of glass made is less. Thus, the fuel cost is less than with powder charging.

(e) There is almost no blow-over from the charge when briquets are melted, because these soften into the molten mass as a whole without disintegration or formation of any fines. The result is that all of the charge put into the furnace goes into the glass; there is thus no waste.

(f) Since there is no blow-over of dust in the products of combustion, the heat interchange in the regenerators is much more efficient than when the passages through the checkerwork are partially choked with dust.

(g) Freedom from dust in the checkerwork also minimizes the danger of slagging down this refractory. When the furnace was rebuilt during the Summer of 1938, practically all the refractory of the checkerwork could be saved and reused, as it was as good as new. This economy in capital cost is not large per ton of glass, but is significant in dollars per year.

(h) Because the briquets melt down as a whole there is not the same tendency for concentration of alkali in the molten glass near the surface. Therefore, there is a slight advantage in reduction of slagging on the furnace walls by the molten batch. Such slagging at the surface of the molten glass is occasionally serious, especially when segregation occurs during melting of a powdered charge.

Natural gas is used exclusively for firing the glass furnace. Burners are ranged on each side of the furnace and for each gas burner there are twin pressure indicators at the control board, showing at all times the gas and the air pressure at the burner. Two 30,000 gal. tanks of propane are maintained to supply fuel gas in case of natural gas failure at any time.

A small compressor takes flue gas from the base of the chimney and recirculates this for mixing with the natural gas at the burners. This dilution of the gas-air mixture with products of combustion is adjusted to give a long, lazy flame which will carry uniform heating clear across the furnace. Thus, there is not too much localization of heat near the burner outlets, nor on the side of the furnace from which firing is taking place at any particular time.

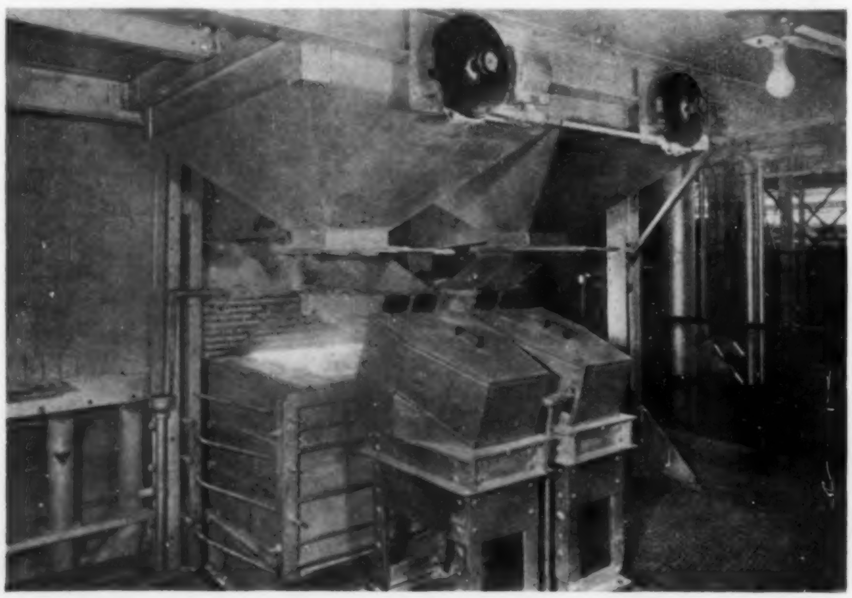
The burners operate in pairs, those on the east and those on the west side of the furnace burning in alternate periods. Until lately, an automatic time mechanism provided for reversal of the firing from one side of the furnace to the other at 15-minute intervals. That gave excellent uniformity of heating on a 30-minute full cycle. But, even so, the engineers were not fully satisfied with the results.

The purpose of reversal from one side of the furnace to the other is to secure uniformity of temperature. It was decided to reverse on the basis of temperature instead of time. Pyrometer controls were installed in the checkers on the two sides of the furnace. When the temperature drops to a predetermined point on the intake side, these pyrometer controls actuate the reversing mechanism. The result is small but definite improvement.

So far as this part of the furnace operation is concerned the operator can be anywhere about the furnace and the clocks can take a permanent vacation. Actually the reversal period still averages about 15 minutes. But small variation in the time interval does occur, to the extent necessary to compensate for irregularities which might otherwise prevail if only time determined the reversal period.

Another novel feature of this furnace is the form of the curtain wall that is suspended on a movable bridge mechanism which permits the placing of the lower edge of this wall at any point desired within range of 18 in. above the molten glass level in the furnace. During warming of the refractory after rebuilding, the cur-

Furnace charging port with briquet-feed hoppers above. Proportioning of the mix for the charge is accomplished through a series of material bins that feed onto a mixing belt through hopper-scale units. This permits accurate control for mixture uniformity



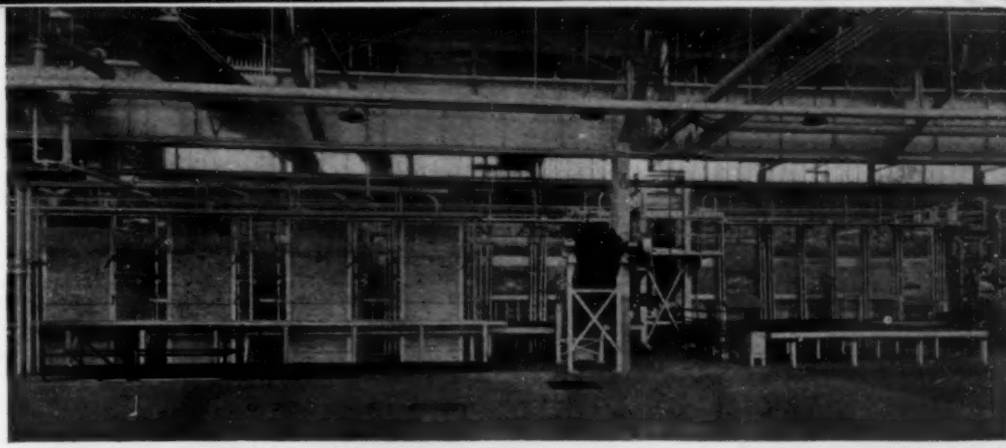
tain wall was raised to its highest point. Thus the warming took place along the entire length of the furnace at a uniform rate. This was a substantial advantage because it minimized the thermal strains which otherwise might have been set up in the refractory. When the temperature was approaching dull red, test showed that there was only 30 degrees difference in temperature between the hot end and the cold end of the furnace. Without elevation of the curtain wall, it is believed that the differential would have been much greater than this.

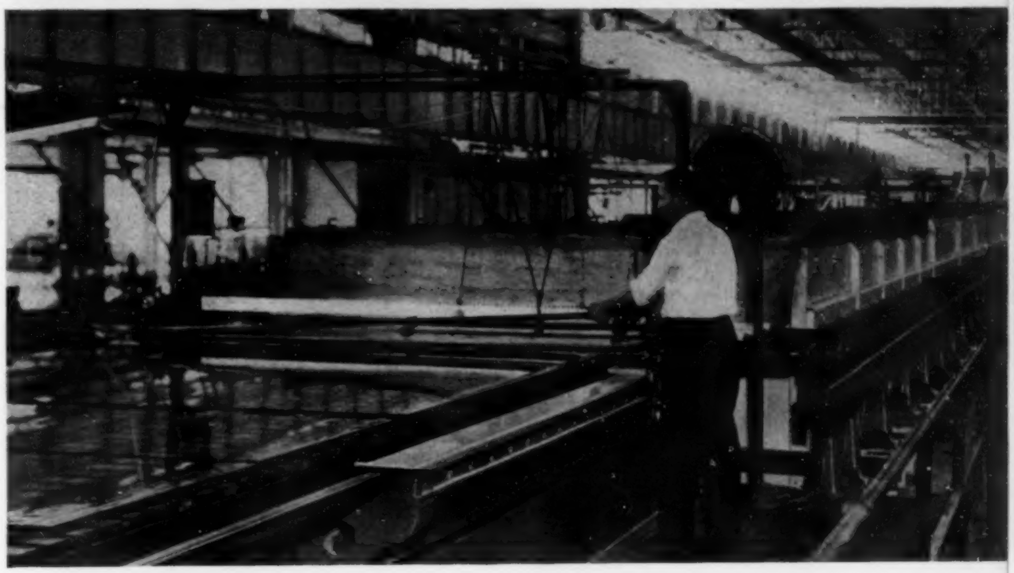
After the furnace was fully heated up and began functioning with its normal glass charge, the curtain wall was worked down gradually until the optimum position was determined. The movable unit was then luted into the fixed wall through which it slides. It is not expected that it will be necessary to move the curtain wall soon. However, it would not be particularly difficult to do so, if that were found desirable in order to secure better temperature distribution throughout the furnace.

The feed of briquets to the furnace is controlled by the operator by varying the speed of vibration of the magnetic feed device at the bottom of the briquet-storage bin. Control here may be so nicely adjusted as to maintain accurately the molten glass level in the draw tank within a range of about a quarter of an inch from its median point. All of this adjustment is done electrically in simple, clean push-button style, by an operator who might come to work in his dress clothes, if there were any occasion for that.

The drawing of a uniform sheet of glass 104 in. wide is not an easy job. But accurate temperature maintenance and smooth speed control of the mechanism contribute greatly to that end. If the power be cut off, the glass then tends to set in the rolls and lehrs. If the power is off during an electrical storm, or for other reason, for more than a very short time the machine may drop its sheet at the draw tank. Then there is, of course, great scurrying. However, the operating crew here has a record of restoring full 104-in. sheet operation in 17 minutes. And that means the operators are extremely skilled in "picking up the sheet".

Exact speed and temperature control at the rolls and in the annealing section of the furnace are essential for good glass making. This installation is the first, if not the only, muffle-type lehr in use for drawn sheet glass. These details have been worked out so that by close instrument control there is the minimum of operating uncertainty.





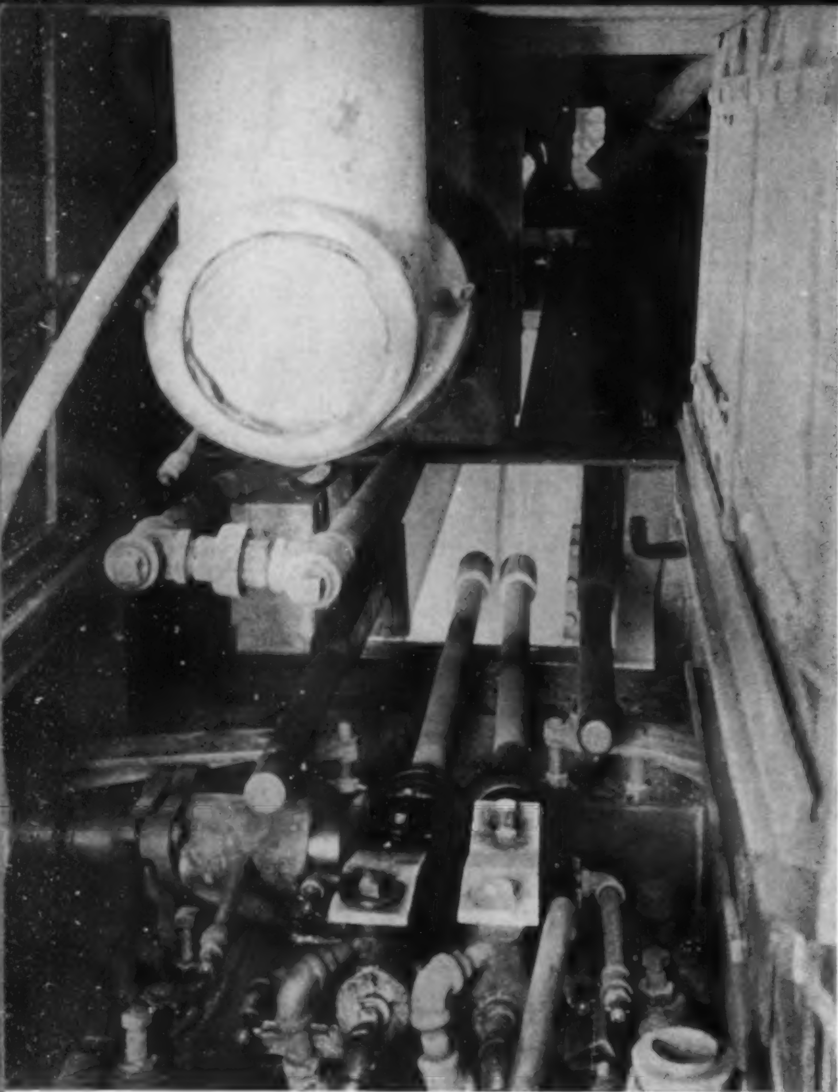
Top—Glass furnace and lehrs are located in the center of this factory. Preparation of the charge in briquet form was originally planned to reduce dustiness of operation of the furnace

Bottom—Cutting operation at capping conveyor. A furnace designed for 75 tons of glass a day on the old basis has easily 100 tons capacity with briquet charging

The discharge from the annealing section is direct onto the cutting table. About 4 in. of width is cut from each edge of the full sheet to give 96 in. of useful glass. That is then cut to brackets and finally by templet to desired shapes and sizes for each particular door and window unit of the car. Edge cuttings and broken pieces go into cullet, which is taken from the end of the cutting table by elevator onto a return belt which discharges this material into a storage bin at the materials end of the furnace. There it is ready for crushing and working back into the mix.

The Ford car still uses ground plate glass for windshield and rear-window openings. But all of the side and auxiliary glasses are made up of this drawn glass, "window glass" to the novice. Even in it any visible waver that might be unpleasant and distort the scenery is not permissible. Hence drawing of this sheet glass, rolling, and cooling must be carried out to get it plain, close to optical perfection.

The life of a piece of safety glass is usually limited by the life of the plastic material which forms the interlayer. In the old days when cellulose nitrate sheet was used, the safety plate began to discolor, become cloudy, or separate in a relatively short time. With cellulose acetate plastic material the deterioration is much less. It is particularly notable that the breakdown of the plastic under actinic rays of the sun is much slower. Even so, the best practice demands that the glass be of rather a dark green character, through suitable iron content, in order to cut off the objectionable rays of the sun before they reach the



Drawing machine. Note edge of hot soft plate being drawn up between guides in center of picture

plastic. This will greatly lengthen the clear life of the safety plate. It is this fact which accounts for the addition of iron to the charging mixture, an addition which is occasioned particularly at this plant by the very low iron content of the sand used.

This plant is beginning the manufacture of safety glass with a vinyl type of plastic. The superiority of that material for long clear life is well recognized in the glass industry. And the motor manufacturer especially realizes the tremendous advantage of a vinyl-type interlayer which does not require edge sealing, as do both types of cellulose safety glass.

The life of an automobile is not extremely long, as compared with a house; but, even so, one of the important criteria for satisfaction in safety glass is freedom during this life from separation, discoloration, or fogginess of the glass. It is not at all unusual with vinyl plastic to get several thousand hours in the exposure equipment without noticeable depreciation. That means perhaps 15 years of normal use as automobile glass without discoloration or fogginess. In other words, with satisfactory interlayer material the life of the glass is greater than the life of the car, so far as light depreciation is concerned.

With cellulose acetate the general technique of assembly is comparatively simple. Two sections of glass coated with adhesive and a sheet of the plastic, all cut to the requisite size and shape, are assembled by hand. They are pressed together for preliminary adherence and the partly finished sandwich is then racked up in trays and subjected to pressure at elevated temperature while immersed in a bath of diethylene glycol in an autoclave.

After removal from the autoclave the permanently assembled sandwich has to be treated to protect the edges of the plastic against air and moisture attack. The assembly is therefore dunked into a mixture of sulphuric and nitric acids which eats out around the edges about 1/16 of an inch of the plastic material. After washing and drying, this edge space is then filled with a black edging compound, which seals the plastic against atmospheric depreciation. The grinding of the edges, in order to have exposed only safe smooth rounded glass is done previous to this sealing operation.

This acetate technique takes time, is a messy proceeding, is decidedly costly, and gives a none-too-sure character to the edge seal. Therefore, for a considerable time the engineers have been working on the development of a vinyl resin laminated glass. The Dearborn plant is producing safety glass in that way to some extent and a portion of the Twin City branch output also will be made with vinyl resin sheet. The shift from acetate to vinyl plastic will have a great advantage because once the sandwich is made up it is only necessary to grind the edge without any other special treatment. Furthermore, the vinyl product has a longer clear life, more nearly true-color vision, and there is less chance of separation in use. (For full discussion of this subject see the article in *Chem. and Met.* by Shertz and Fix. April, 1936, page 177.)

This comprehensive development of safety glass manufacture at the Minneapolis-St. Paul unit of the Ford Motor Co. is only one part of the extensive program of enlargement and integration which is under way. This integration is, however, somewhat different for the Ford enterprise than for others. It does not mean solely centralization. In fact, the Ford company is dividing its operations and localizing a considerable number of its manufacturing projects in communities remote from headquarters.

The test which is applied by Ford executives to each new proposition of this sort is two fold. First, it must be proven that any new project will not depreciate the quality of the finished car. Improvement in quality and performance is necessary for acceptance of a modified manufacturing plan. Secondly, the economic test is applied—What is the effect on the *over-all* cost of the finished automobile delivered to its owner? The cost on one part of an operation is of no consequence, but the effect on the price of the car delivered is. Evidently the new glass technology at the Twin City branch has successfully passed both of these tests.

Calco Holds Open House

By throwing open the doors and inviting in the neighbors this chemical company has done a real service in building a more sympathetic and friendly attitude on the part of the American people toward American industry

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The Calco Chemical Co.
Bound Brook, N. J.

LAST YEAR, 1938, marked the 250th anniversary of the founding of Somerset County, N. J., and the week beginning May 15 was set aside for the special observance of the event. The Calco Chemical Co., Inc., at Bound Brook, decided to contribute to the celebration of the event by inviting its friends and neighbors to visit the plant so that they might see what was being done there and become better acquainted with the company.

By means of newspapers and posters, a cordial invitation was extended to everyone 16 years of age and over, to attend the Calco Open House on May 14 and 15. In addition, letters were sent to the heads of all the municipalities in the county inviting them and their families; to the presidents of all the boards of education, and to school principals, urging them to bring groups of their older students to visit the plant; and to the editors of the newspapers in the surrounding towns. Three sets of news releases were issued, the first announcing the Open House, the second detailing plans and telling how they were progressing, and the third outlining the final arrangements.

Predictions as to the probable attendance varied from the skeptic's 50 to the optimist's 500. The actual number was 2,031—in spite of the fact that it rained.

On their arrival, plant police directed automobile drivers to reserved spaces in the parking-yard and the occupants to the reception lobby where they were welcomed by company officials. Guides, about forty students and young technical men especially trained for the purpose, took charge of small groups of the visitors. The first part of the journey was made through the office building. In the paper laboratory, the visitors saw paper made and dyed and received samples of the finished product. After

The families of the employees and the citizens of the community to the number of 2,031 were escorted through the plant

watching chemical apparatus in operation in the research department, the journey continued through the accounting division and the mailing, tabulating, central typing and transcribing and medical departments. At each stop, the guides explained the work done in the department and answered innumerable questions.

At the first stop in the manufacturing division, the visitors saw an orange dye made and wool dyed with it, the entire process being completed within two minutes. They gazed with awe at the tremendous machines in the power plant, looked through windows at sulphur being burned (it was too hot to take them into the building). Then they were taken through the stores building where they commented on the amount of material ready for shipping.

The tour ended at the maintenance building where the Open House theme, "Calco in Your Daily Life," was developed through a variety of displays in booths holding a series of non-technical exhibits dramatizing the part that color plays in everyone's daily life. They included a typical living-room, kitchen, bathroom, office, etc., and clearly pointed out the way color (and hence, Calco) enters into daily living. One booth was devoted to articles showing how color has a prominent place in sports, and another, by means of maps, showed where Calco customers are located in the United States and throughout the world.

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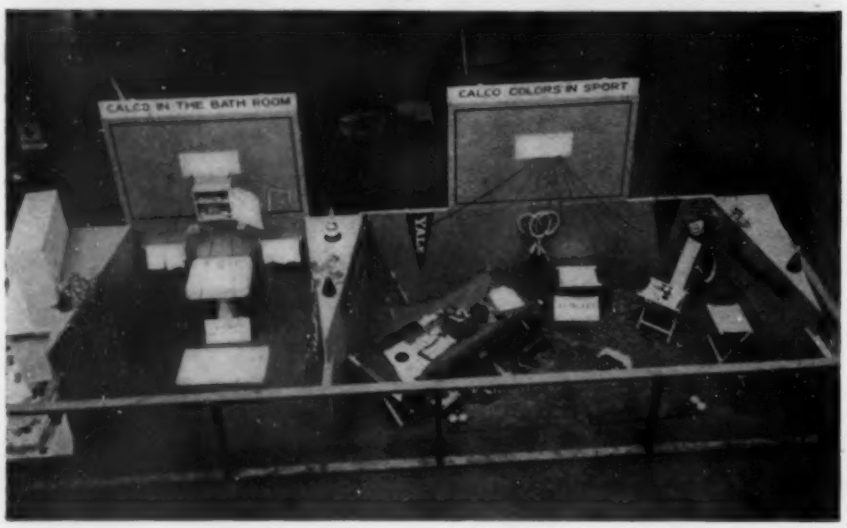


Everything was done looking toward the comfort of the visitors. At the beginning of the tour they climbed two flights of stairs, but the rest of the trip, with one exception, was either downward or on the level. Groups were started at intervals to avoid crowding. The trip from the office to the maintenance building took one hour and twenty minutes—in allowing plenty of time to see everything and to ask questions. Employees entertained their families and friends at dinner or with light refreshments at the plant cafeteria.

As the visitors left the plant, each was presented with a booklet "As You Pass By," the cover-page of which carried, in addition to the title, a picture of the entire plant. The booklet informed the reader that "The dyes which give color to your clothing, to your home, and to the dozens of other things you use in everyday life—even postage stamps—are made in our plant at Bound Brook. And medicine as well to cut short illness and hold infection at bay. Their making means work for more than 3,000 men and women, most of whom live in Somerset County and use their $5,000,000 annual payroll to pay for food and clothing, homes and schools and all the things that are used in the business of living."

That the visitors appreciated the opportunity to see the plant from the inside, and were surprised and interested in what they saw, is amply demonstrated by remarks heard by the guides, some of which follow: "fine; not overdone; educational; opened my eyes; first time I ever knew what Calco makes; everyone has been so courteous and friendly that I have thoroughly enjoyed my visit; this has been a fine, educational experience for my students, and I am grateful to your company for giving us this opportunity; I was very glad to see the place where my husband works."

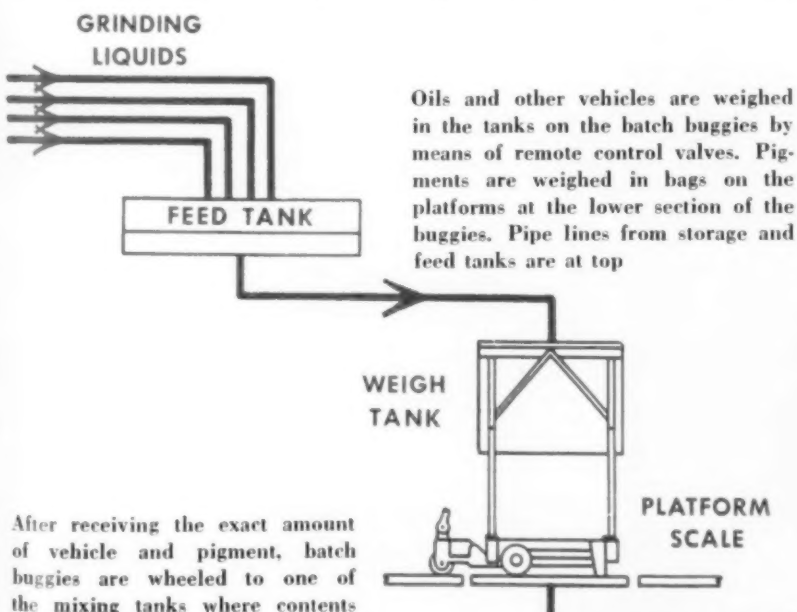
Another gratifying reaction was the wholehearted endorsement of the Open House by the newspapers. In addition to regular news articles, several favorable editorials appeared. Adding up all the results, the Calco executives felt that Open House had definitely created a better understanding between Calco and its neighbors. They also felt that if more industries would open their doors and invite in the public, they would find that they were doing a real service in building a more sympathetic and friendly attitude on the part of the American people toward industry.

Modern Equipment—Better Paint

THE AMERICAN PAINT INDUSTRY has received the concentrated attention in recent years of several thousand chemists and engineers. It is not surprising, therefore, that the number and variety of new paints made available since the War are almost without limit. A modern "complete" paint production unit consumes at least 2,000 raw materials and produces about ten times that number of finished products of different grades, colors and shades.

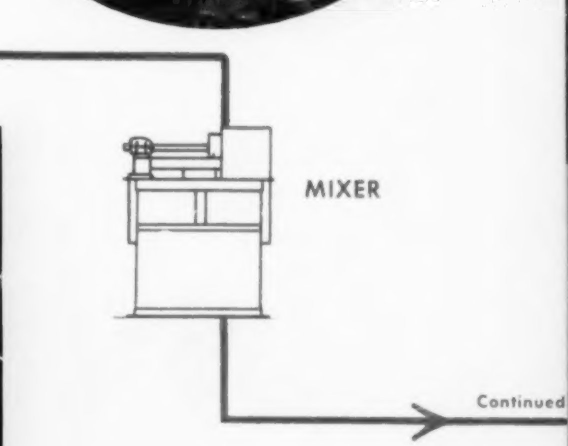
One of the largest and most modern paint plants in the United States is that of the Pittsburgh Plate Glass Co. at Milwaukee, Wis. In this and in most other modern paint mills there are two different lines of flow of materials, one is for mass production of a variety of large gallonage products and the other for special paints developed for individual use by a large number of industrial customers. Essential steps in the first of these are illustrated here by both diagrammatic and pictorial flow sheets. In addition are shown illustrations of a few of the different types of grinding mills used in the production of special paints for customers.

The first operations to be considered are housed on the fifth or top floor so that, as the processing continues, the materials can be transferred easily and economically by gravity to the subsequent steps of manufacture on the lower floors. The weighing, assembling and mixing of the pigments and vehicles having been completed on the top floor the mass is conveyed to the floor below where the grinding is done. Thinning and tinting follows on the third floor, while screening tinted liquid paint into the hoppers of the filling machines is the next operation. The automatic filling and labeling of cans is done on the second floor, and the packaging and shipping on the ground floor. These several operations in the plant of the Pittsburgh Plate Glass Co. are illustrated in these several pages.



Oils and other vehicles are weighed in the tanks on the batch buggies by means of remote control valves. Pigments are weighed in bags on the platforms at the lower section of the buggies. Pipe lines from storage and feed tanks are at top

After receiving the exact amount of vehicle and pigment, batch buggies are wheeled to one of the mixing tanks where contents are easily transferred to a mixing container



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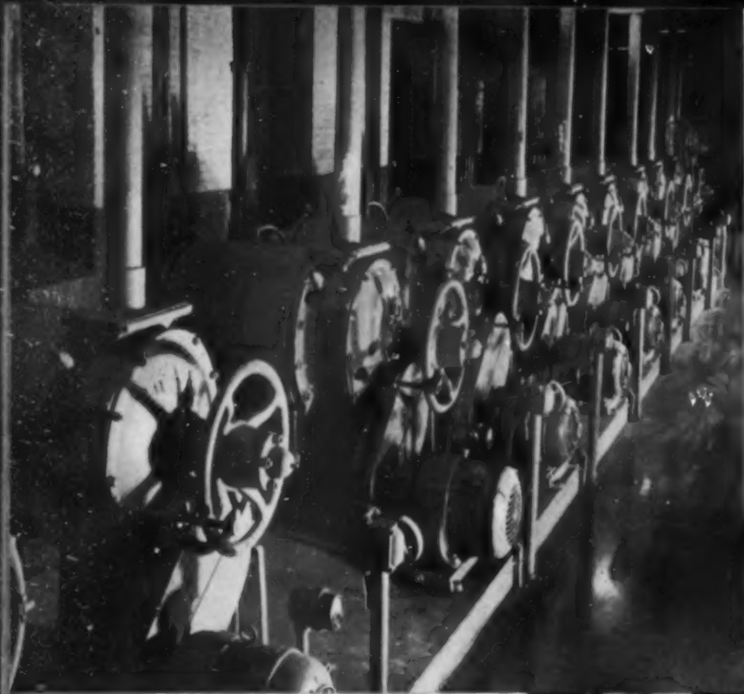
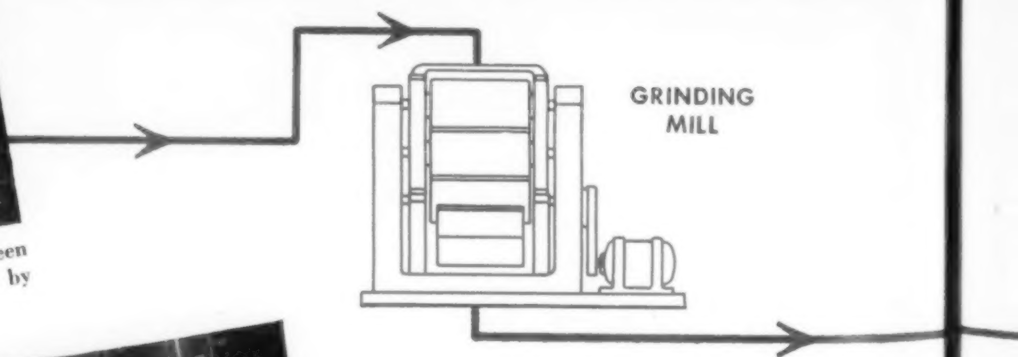


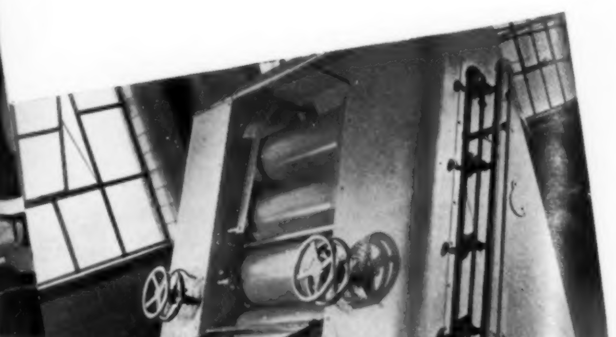
A variety of types of grinding mills are used in production of both so-called trade sale products and industrial finishes. Several of the different types are illustrated on this and the facing page. Below is a group of five-roller mills of modern design

The batch is transferred from mixing tanks to grinding mills on the floor below through conveniently located openings in the floor beside the tanks. Bramley mills are one of several types in use

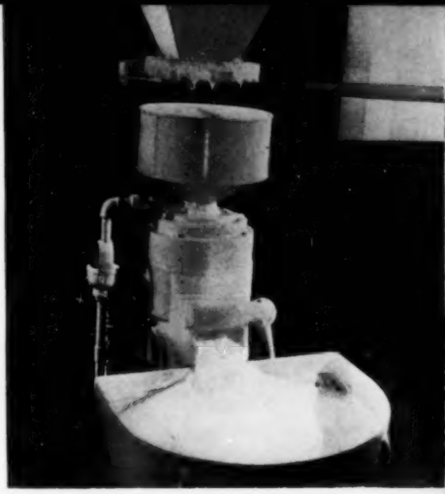
One of the oldest methods of grinding paints is between two stones. In modern mills these stones are driven by electricity



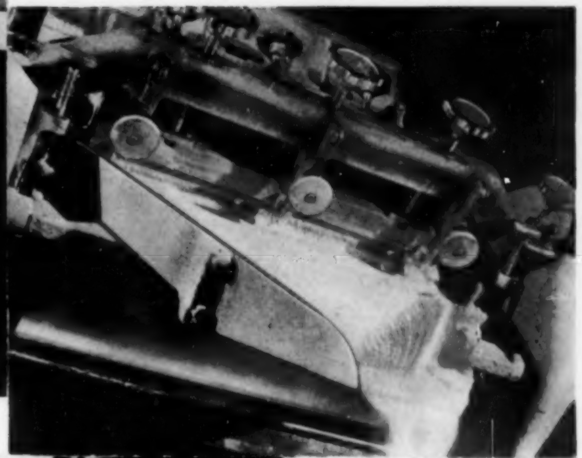
Three-roll steel mill. All types of grinding methods are used either individually or collectively in this plant



Five-roll steel mill. The different types of grinding equipment result in a varying production rate of from one to 1,000 gal. per hr.

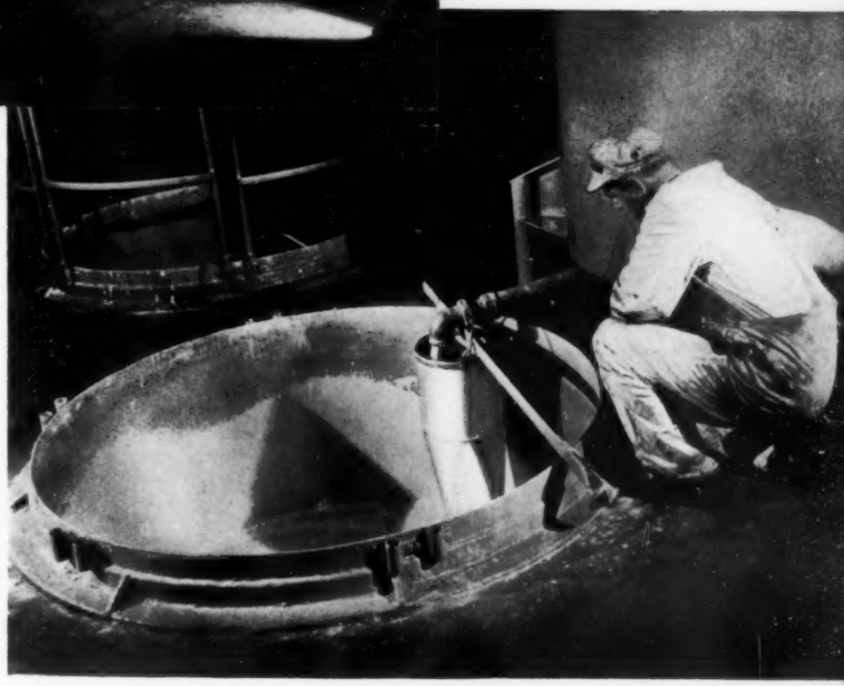


A high-speed Carborundum stone mill. Space does not permit the illustration of every type of grinding equipment in use in this plant

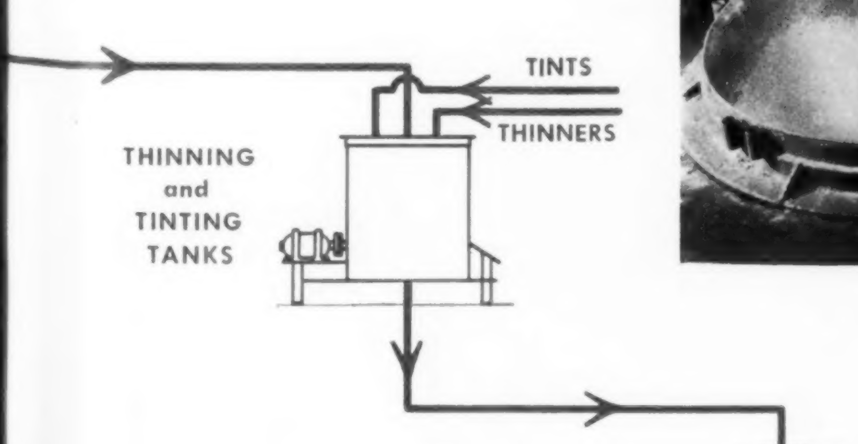


Single steel roll with adjustable grinding bar. The wide difference in hardness of various pigments, the equally wide difference in effect of heat on oils and varnishes, and the cost, all must be considered in selection of grinding equipment

A battery of 600 and 300 gal. thinning and tinting tanks, each one of which is equipped with its own motorized agitator, and constructed so that an electrically powered truck can be used to transport any one of the tanks to any position on the floor



Thinned and tinted paint is being fed through fine screen from third floor thinning tanks into the top of filling machine hopper on the second floor. Note easy accessibility which facilitates cleaning equipment



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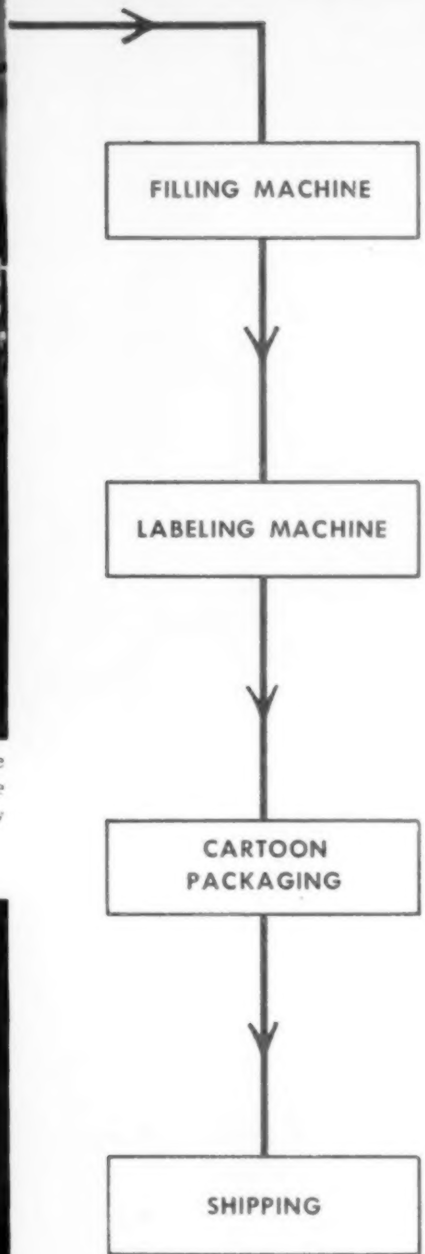
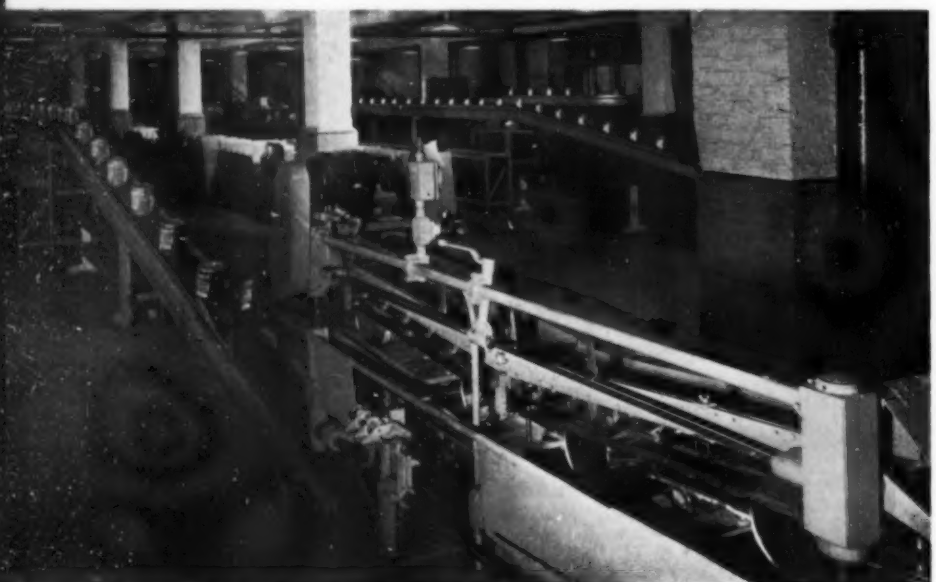
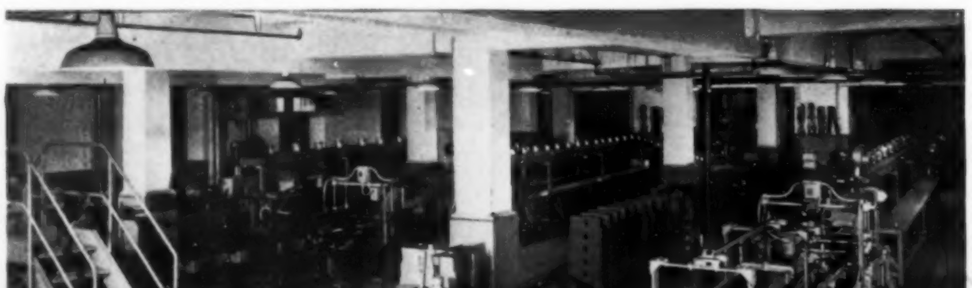
It is through the comparatively small outlets extending from bases in the four hoppers to the tops of automatic filling machines that products are conveyed into cylinders, which allow the correct volumes to flow into empty cans passing slowly beneath them





After being filled and automatically capped, cans are carried on belt conveyors to labeling machines, pass through this operation and continue on the conveyor to the point where they are transferred to cartons

Cartons are closed by machines and pass on to the shipping department. All operations are automatic with manpower being used only in supervisory capacity



Graphic Control of Plant Solutions

Strengthening or "butting-up" of factory solutions is a problem easily solved by graphical methods. Herein are presented a derivation of a general "butt-up" equation and simple rules for the construction of three types of nomographic charts.

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In numerous chemical plants, there arises a necessity for regulating the concentration of various solutions. The problem usually involves the determination of the amount of solute and solvent to be added. In most cases this problem may be solved easily and quickly by reference to a nomograph. Further, the authors found that the required nomograph could often be constructed by men employed in routine control testing, provided they adhered to certain simple fundamental rules which constitute the subject matter of this paper.

No attempt will be made here to discuss the mathematics of nomography or even to describe all the types of nomographs. These things have been adequately covered in numerous books on graphical methods by such men as Joseph Lipka, D. S. Davis and R. P. Genereaux (Chemical Engineer's Handbook), L. I. Hewes and H. L. Seward, and Merrill G. Van Voorhis. Suffice it to say that the fundamental principle of nomography is the representation of an equation of three variables (two independent and one dependent) by means of three scales in such a manner that a straight line intersects all scales in values satisfying the equation.

The authors found that the first three types of nomographs discussed by Lipka were sufficient for the present purpose. Consequently, the method of constructing these types is described below in detail together with directions for application to solution control.

General Instructions

Step I. Set up or develop an equation or equations for the particular problem. *Illustration 1*—Let it be required to set up an equation for the batch "butting-up" of the sodium hypochlorite or "bleach" solution tank. Data and variables pertaining to this solution control problem were as follows:

K = tank constant = 30 gal. per inch of solution

D = depth of solution in tank varied from 10 in. to 50 in.

C_o, C_f = initial (varied from 0 to 0.099 grams available chlorine per 100 c.c. of solution), and desired final concentration (0.10 grams available chlorine per 100 c.c. of solution).

B = concentration of butting-up sodium hypochlorite solution (varied from 0.25 to 0.60 grams available chlorine per 100 c.c. of solution).

I = inches of butting-up sodium hypochlorite solution to be added to bring the strength from C_o at a depth of D in. to 0.10 (C_f), grams of available chlorine per 100 c.c. of solution.

Derivation of the butting-up equation for this particular problem is based on material balance computation and was set up as indicated below.

Let X = pounds of sodium hypochlorite (in terms of available chlorine) after butting-up or at desired concentration of C_f.

Y = pounds of sodium hypochlorite (in terms of available chlorine) at concentration C_o, and a depth of D in.

Z = pounds of concentrated butting-up sodium hypochlorite of concentration B to be added to bring the strength in the tank from concentration C_o to concentration C_f.

Then by a material balance:

$$X = Y + Z \qquad (1)$$

$$\text{Where } Y = \frac{D \times K \times 3.785 \times 10 \times C_o}{453}$$

$= 0.0835 DKC_o$.

Then 0.0835 is the factor for converting grams per 100 c.c. to pounds per gallon.

Also where $Z = 0.0835\, I\, K\, B$

and where $X = 0.0835\,(D + I)\,K\,C_f$

Rewriting the material balance

$0.0835(D + I)\,K\,C_f = 0.0835\,D\,K\,C_o + 0.0835\,I\,K\,B$

Simplifying, and solving for I

$$I = \frac{D\,(C_f - C_o)}{(B - C_f)} \qquad (2)$$

Equation (2) is a general butt-up equation and is applicable to many solution control problems.

Substituting the values for this particular problem:

$$I = \frac{D\,(0.10 - C_o)}{(B - 0.10)} \qquad (3)$$

Equation (3) is the equation set up for this particular illustration.*

Illustration 2—Let it be required to set up equations for computing the amount of water and also 20 per cent by weight of caustic soda solution to be added to a batch of cellulose xanthate in the dissolvers to produce viscose containing 5 per cent NaOH and 8 per cent cellulose.

Let O = original weight of batch of cellulose xanthate (varied from 500 to 600 lb.)

C_o = original per cent by weight of cellulose in the batch (varied from 25 to 30 per cent)

N_o = original per cent by weight of NaOH in the batch (varied from 13 to 20 per cent by weight)

W = pounds of water to add to batch of cellulose xanthate

A = pounds of 20 per cent by weight caustic soda solution to add to batch of cellulose xanthate.

Then M (weight of final batch of viscose) $= O\,C_o/8 = 0.125\,O\,C_o$

H (weight of caustic soda in the original batch) $= O\,N_o/100$

M' (weight of caustic soda in the final batch of viscose) $= 5M/100$.

$$A = \frac{M' - H}{0.20} = \frac{0.05\,M - 0.01\,O\,N_o}{0.20} \qquad (5)$$

$$W = M - (A + O) = 0.125\,O\,C_o - (A + O) \qquad (6)$$

Therefore,

Equations (5) and (6) were the butting-up equations for Illustration (2).

Step II. Split up equations of more than three variables into equations of three variables which include auxiliary connecting variable or variables.

The writers have illustrated previously (*Trans.* A.I.Ch.E., Aug. 25, 1938, pp. 387-409) the application of graphical methods to factory solution "butting-up" (or strengthening) problems, and have given some typical characteristic charts used by them in large rayon plants for solution control work. However, none of the details concerning methods of construction of these charts were given in that paper.

*Quite often it is not convenient or practical to add the concentrated butting-up solution in terms of inches of the tank. Smaller units which lend themselves to easy calibration of a bucket or a small tank are used—the *liter* (L) is a convenient unit. The general butt-up equation for this particular problem then becomes:—

$$L = \frac{113.55\,D\,(0.10 - C_o)}{(B - 0.10)} \qquad (4)$$

For example, Equation (3) was split up as follows:

$$U = D\,(0.10 - C_o) \qquad (3a)$$

$$U = I\,(B - 0.10) \qquad (3b)$$

The variable U in Equations (3a) and (3b) is known as the auxiliary connecting variable. Similarly Equations (6) and (5) were split up as follows:

Equation (6)

$$M = 0.125\,O\,C_o \qquad (6a)$$

$$T = A + O \qquad (6b)$$

$$W = M - T \qquad (6c)$$

Equation (5)

$$H = 0.01\,O\,N_o \qquad (5a)$$

$$0.20\,A = 0.05\,M - H \qquad (5b)$$

Step III. Determine *type form* of these three variable equations. The writers found that practically all solution problems can be classified in one, or two of the first three types discussed by Lipka. However, other type forms sometimes give charts that are not as complicated. Equations (3), (4), (5), and (6) were classified as outlined in Table I.

Fundamental Rules

1. Equations having type form I and III are compatible, while Type II equations are not compatible with Types I and III. Therefore, equations of more than three variables containing a combination of addition, subtraction, multiplication, or division must be constructed according to the principles of Type I and Type III.*

Since Equations (5a) and (6a) of Illustration 2 can be considered either Type II or Type III equations, and Equations (5c) and (6c) are Type I equations, the nomographic chart for this problem must be constructed according to the principles of Type I and Type III equations, and not Type I and Type II since they are not compatible. Equations (5a) and (6a) must therefore be considered only as Type III equations.

2. Terms in an equation such as $(0.10 - C_o)$ and $(B - 0.10)$ in Equations (3a) and (3b) respectively, are considered as one variable.

3. *Scales* are used to represent the values of a single variable, and also functions of a single variable of an equation. For example scale D (Fig. 1) represents the values of the variable D, and scale B (Fig. 1) represents the values of the functions of B, namely $(B - 0.10)$. The graduations on each scale, and consequently the length, are determined, as will be brought out later, by the ease of graduation, the accuracy desired, in some cases by the moduli chosen or determined for other scales, and by the nature of the functions.

4. The length of unit segment of a scale is called the "scale modulus" and is designated by the letter m with subscript to identify the scale. Expressed mathematically

$$\text{Scale modulus} = m = \frac{\text{Length of scale (inches)}}{\text{Upper limit of variable—Lower limit of variable}}$$

For example,

$$m_o = \frac{10}{600 - 500} = 0.10$$

Similarly, scale C_o, Fig. 1:

$$m_{C_o} = \frac{10}{\text{Log }(0.10\text{-}0) - \text{Log }(0.10\text{-}0.099)}$$

$$= \frac{10}{(10.000\text{-}1) - (10.000\text{-}3)}$$

= 5 (which is identical with the modulus of one cycle of a 5-in. slide rule).

5. The "equation of the scale" of a variable gives the distance between any two values on the scale, the length of the scale, and hence the type of scale to be used in graduating a given scale. The distance x between any two divisions on a scale is computed from the equation of the scale. This is determined by the *function* of the units of graduation $f(u_g)$ desired, and the scale modulus of a particular scale. Expressed mathematically, $x = m\,f(u_g)$.
The equation of the scale determines the length of the scale.

For example, the distance between each pound graduation of the O scale (Fig. 6) is

$$x = 0.1\,(1) = 0.1 \text{ in.}$$

Since the length of this scale was previously stated to be 10 in., it had to be graduated with an arithmetical scale of 10 units per inch.

Similarly, from the above, the distance between 0 and 0.09 on the C_o scale (Fig. 1) is

$$x = 5\,[\text{Log }(0.10\text{-}0) - \text{Log }(0.10\text{-}0.09)]$$

$$= 5\,(\text{Log } 0.10 - \text{Log } 0.01) = 5 \text{ in.}$$

Therefore, each cycle of this scale (0 to 0.09, and 0.09 to 0.099) had to be graduated with a logarithmic scale in which the cycle from 1 to 10 was 5 in.

The equation of the scale should not be confused with the scale modulus. In most solution control problems they appear to be identical. This identity disappears when we consider the case of the representation by a scale of $y = v^2$, in which the modulus of the v scale was 10 and v varied from 1 to 10. The scale would have to be graduated by a scale corresponding to a 20 in. slide rule (or a cycle length of 10 in.) and not 10 in. as would appear from consideration of scale modulus, as shown by the following computation:

$$x = mf\,(u_o) = 10\,(2 \text{ Log } 10 - 2 \text{ Log } 1) = 20 \text{ in.}$$

6. When Type I and Type II equations have the form of $x - y = z$, and $\text{Log } X - \text{Log } Y = \text{Log } Z$ respectively, the X and Y scales are graduated in opposite directions.

7. The relationship between two variables can be represented graphically by a *stationary scale*, such as a scale having on the right of the center line one graduation and on the left a different graduation such as degrees C. and F., respectively.

The relationship of M of Equation (6), and $0.05\,M$ of Equation (5) may also be represented by such a scale. The modulus of each variable for one particular scale is, however, different.

Detailed Steps for the Construction of Charts

Part A. For Type I and Type II Equations. The various detailed rules and steps showing how charts for Type II equations are constructed will be illustrated by giving all the details of computation and construction for the nomographic chart for Equation (3),

* In some special cases Type I, II, and III equations can be made compatible by constructing the scales according to the method outlined by Lipka and by Hewes and Seward.

Table I—Three Type Forms of Nomographic Equations

Type	Equation Form	Examples	Chart Form
I	$X + Y = Z$	$A + O = T$ (6a) $M - T = W$ (5a) $0.05\,M - H = 0.20\,A$ (5b)	3 parallel scales graduated uniformly. (Arithmetically as architects rule, e.g., A scale, Fig. 6)
II	$XY = Z$ When written in the form: $\text{Log } X + \text{Log } Y = \text{Log } Z$	$D\,(0.10 - C_o) = U$ (3a) $I\,(B - 0.10) = U$ (3b) $0.125\,O\,C_o = M$ (6a) $0.01\,O\,N_o = H$ (5a)	3 parallel scales graduated logarithmetically (as a slide rule, e.g., D scale Fig. 1)
III	$XY = Z$	$0.125\,O\,C_o = M$ (6a) $0.01\,O\,N_o = H$ (5a) $D\,(0.10 - C_o) = U$ (3a) $I\,(B - 0.10) = U$ (3b)	2 parallel scales graduated arithmetically, and one oblique scale graduated by projections from one of the arithmetic scales (e.g., C_o scale Figs. 5 and 6)

Table II—Data for Construction of Nomographic Chart for Equation (3) (Fig. 1).

Equations	Scale	Limits	Modulus	Location of Scale (in.)	Graduating Scale to be Used. Remarks.
Equation (3a) $D\,(0.10 - C_o) = U$ (Type II)	D	10 to 50 in.	10	....	Logarithmic scale, 1 cycle = 10 in. Graduate in units of 1 in. depth solution in tank.
	C_o	0 to 0.1	5	$C_oD = 9$*	Logarithmic scale, 1 cycle = 5 in.
	U	Immaterial	3.33	$UD = 6$	Scale not graduated. Represented by straight line.
Equation (3b) $I\,(B - 0.10) = U$ (Type II)	U	Immaterial	3.33	$UD = 6$	Scale already constructed for Equation (3a). Scale not graduated.
	I	0 to 10 in.	5	$UI = 2$	Logarithmic scale, 1 cycle = 5 in.
	B	0.25–0.60	10	$UB = 4$	Logarithmic scale, 1 cycle = 10 in.

* $C_oD = 9$ in. represents distance between C_o and D scale.

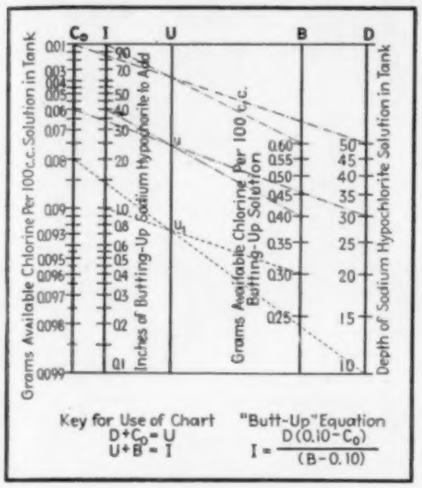
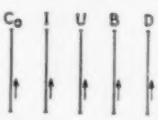


Fig. 1—Bleach butt-up chart

which has been previously shown to contain two Type II equations (3a and 3b). The completed chart is shown in Fig. 1. The rules and steps for Type I equations are identical with Type II except that arithmetic scale of graduations are used in the former case and logarithmic in the latter.

Step IV-A. Construct a skeleton diagram of the chart to be constructed keeping in mind that the connecting link between the three variable equations split up from the main equation as the auxiliary connecting variable. Also remember that the Z scale is *always* the middle scale. Indicate on this diagram the direction of graduation of each scale.

For example, in Equations (3a) and (3b), the variable U is the auxiliary connecting variable, and also corresponds to the Z scale. Therefore, the U scale has to be the middle scale. (This rule was kept in mind when Equation (3) was split up in Step II).[*] The skeleton diagram for Equation (3) is shown in Fig. 2.



Step V-A. Choose any convenient arbitrary moduli for *two scales* (these will fix the length of the scale as stated previously) which will represent graphically two of the variables of one set of three variable equations.

Moduli of 10 and 5 were chosen as convenient moduli of the D, and the $(0.10 - C_o)$ scales, respectively, of Equation (3a). These two variables correspond to X and Y of the general equation $\text{Log } X + \text{Log } Y = \text{Log } Z$.

Step VI-A. Compute the modulus of the third scale from the following equation

$$m_z = \frac{m_x \times m_y}{m_x + m_y} \qquad (7)$$

The modulus of the U scale was then computed by substituting the appropriate values in Equation (7).

$$m_U = \frac{m_D \times m_{C_o}}{m_D + m_{C_o}} = \frac{10 \times 5}{10 + 5} = 3.33$$

Step VII-A. Assign any convenient arbitrary modulus to *one scale* representing graphically one of the variables of the second set of three variable equations. (It will be noted that a modulus has already been determined for the auxiliary connecting variable U.) This step can be considered as a repetition of Step V-A.

A modulus of 10 was chosen as a convenient modulus of the B scale.

Step VIII-A. Compute the modulus of the third scale of the second set of three variable equations by means of Equation (7).

The modulus of the I scale was computed as indicated below:

$$m_U = \frac{m_I \times m_U}{m_I + m_U};\ 3.33 = \frac{m_I \times 10}{m_I + 10};\ m_I = 5$$

Step IX-A. Choose any convenient distance between two scales which will represent graphically two of the variables of a three variable equation. Indicate this distance on the skeleton diagram constructed in Step IV-A.

The distance between the D and C_o scales was chosen arbitrarily as 9 in. (Equation 3a). And the distance between the I and B scales was chosen arbitrarily as 6 in. (Equation 3b).

Step X-A. Compute the distance between the Z scale and either the X or Y scales by one of the two equations given below.

$$\frac{ZX}{ZY} = \frac{m_x}{m_y} \quad (8); \qquad \frac{XY - ZY}{ZY} = \frac{m_x}{m_y} \quad (9)$$

Where ZX = distance between Z and X scales, ZY = distance between Z and Y scales, and XY = distance between X and Y scales.

Since the Step IX-A the distance XY was chosen arbitrarily, Equation (9) was used to compute the Y scales of Equations (3a) and (3b). For example:

$$\frac{9 - UC_o}{UC_o} = \frac{10}{5}; \qquad UC_o = 3 \text{ in.}$$

Similarly

$$\frac{6 - UB}{UB} = \frac{5}{10}; \qquad UB = 4 \text{ in.}$$

Step XI-A. Prepare a table indicating the pertinent information necessary for the construction of a chart for a particular equation.

Table II exhibits the information necessary for the construction of the nomographic chart for Equation (3).

Step XII-A. Construct parallel vertical lines for each of the scales representing variables with respective distance between each scale as specified in Table prepared in Step XI-A. These lines were constructed for the following scales: D, C_o, U, I, and B as shown in Fig. 1.

Step XIII-A. Graduate all the scales with the exception of the scale representing the final variable of each major equation (for example, the I scale of Equation (3), the A scale of Equation (5), and the W scale of Equation (6) by the type of scale specified in the table prepared in Step XI-A, and as calculated previously under Rule 5. Note that the graduations on a given scale are functions of a single variable. But since the numerical value of the variable is the important item in the ultimate use of the chart, it is written at the point on the scale corresponding to the actual value of the function.

The C_o, B, and D scales, Fig. 1, were graduated as indicated below. It was not necessary to graduate the U scale as this scale represents the auxiliary connecting variable, whose points only emerge (and that temporarily) during each use of the chart in particular cases, and change with each new problem.

Graduation of C_o Scale—This scale was graduated as specified in Table II with a logarithmic scale having a cycle length of 5 in. Since the scale length was computed to be 10 in. to cover the entire range of the variable C_o, the logarithmic scale had to contain two 5 in. cycles. It will be noted especially that values of the variable C_o, as 0.099, 0.09, and 0.00, correspond to the values 0.001, 0.01, and 0.10, respectively, of the function represented by the two-cycle logarithmic scale.

Graduation of the D and B Scales—These scales were graduated between their respective limits with a logarithmic scale having a cycle length of 10 in. However, it will be noted that the representation of the variable B on the B scale was similar to that of the C_o scale, namely, values of the variable B in the equation as 0.25 and 0.60 correspond to values 0.15 and 0.50, respectively, of the function represented on the 10 in. cycle logarithmic scale.

Step XIV-A. Graduate the final variable scale as indicated in the example given below for the graduation of the I scale of Equation (3).

The I scale, Fig. 1, was graduated in the following manner:—

1. Two sets of values were arbitrarily assigned (with the limits of the respective variable) to C_o, D, and B; these were ($C_o = 0.08$, $D = 10$ in., and $B = 0.30$), and ($C_o = 0.00$, $D = 50$ in., and $B = 0.60$).

2. The corresponding values of I were computed from Equation (3), for example

$$I = \frac{10\ (0.10 - 0.08)}{(0.30 - 0.10)} = 1 \text{ in};$$

$$I = \frac{50\ (0.10 - 0.00)}{(0.60 - 0.10)} = 10 \text{ in.}$$

3. On Fig. 1, 10 of the D scale was joined with 0.08 of the C_o scale with a

straight line and the point of intersection u_1 was marked on the U scale. Then u_1 of the U scale was joined with 0.30 of the B scale and the point of intersection was marked on the I scale with the corresponding value of I, namely, 1 in. (depth of tank). These lines are indicated by dash on Fig. 1.

4. On the same figure the same procedure and the same order were followed for the second set of assigned values namely, 50, 0.00, and 0.60 respectively. These lines are indicated by dot-dash lines on Fig. 1.

5. Since the I scale was to be graduated as stated previously with a logarithmic scale having a cycle of 5 in. such a scale was slid along the I scale until the points 1 and 10 of this scale coincided with points 1 and 10 marked on the I scale in the steps given above. Other points on this scale were graduated by means of this 5 in. cycle logarithmic scale.

Construction of the nomographic chart for Equation (3) was thus completed and is shown in Fig. 1.

Application of Bleach Solution Butt-up Chart

Consider the following problem:

The bleach liquor tank contained 30 in. of solution of concentration 0.06 grams of available chlorine per 100 c.c. of solution. Let it be required to compute the inches of butting-up sodium hypochlorite solution of concentration 0.40 grams of available chlorine per 100 c.c. of solution to be added to the bleach liquor tank so that the resulting solution will be 0.10 grams of available chlorine per 100 c.c. of solution.

Solution by Nomograph—Graphical solution by the nomograph is shown by dash-double dot construction in Fig. 1. The steps in the graphical procedure were as follows:

1. Joined 30 (D scale) and *0.06* (C_o scale) with a straight line and marked its point of intersection u on the U scale.

2. Joined u (U scale) and 0.40 (B scale) with a straight line and marked its point of intersection, 4 in. on the I scale. Therefore add 4 in. of butting-up sodium hypochlorite solution to bleach liquor tank.

Part B: Combination Type III and Type I Equations.

Rules and illustrations showing how Type III equation charts are constructed, and also how this type of chart may be combined with Type I to give a chart which finds application in many solution control problems will be illustrated by giving the details of computation and construction for Equations (5) and (6). The completed chart is shown in Fig. 6. The order of steps given after Step IV-B (below) is the order determined by the set up of the skeleton representation of Equations (5) and (6); other butt-up problems may require an altogether different order. **However, the basic** principles are the same in each case. Detailed procedure for the construction of a Type III equation chart will be illustrated by means of Equation (6a), and as indicated in Steps IV-B to XIII-B.

Step IV-B. Make a skeleton diagram of the chart to be constructed keeping in mind that the connecting links between the three variable equations split up from the main equations were the auxiliary connecting variables, and in some cases equations of stationary scales. Also review the fundamental rules concerning charts for Type III equations, namely:

1. The Z scale is *always* a vertical scale.

2. Either the X or Y scale can be vertical scales, *never both.*

3. The oblique scale (which is either the X or Y scale) joins the zero graduations of the two vertical scales. Therefore, the graduations of the two vertical scales are in opposite directions. For convenience of expression in this paper the X scale will be considered the vertical scale, while the Y scale will be considered oblique.

For example, the skeleton diagram for Equations (5) and (6) is shown in Fig. 3. The procedure in its construction was as follows:

1. Drew the skeleton representation of scales of Equation (6a) ($M = 0.125OC_o$). M corresponded to Z; O to X; and C_o to Y, respectively, of the general equation. As stated previously, the M scale in addition to being a scale representation of the variable M in Equation (6a) is also the stationary scale representation of the variable M (or 0.05M) of Equation (5c) and is therefore the connecting link between Equation (5) and (6).

2. Drew the skeleton representation of Equation (5a) ($0.01\ O\ N_o = H$). It will be noted that the O scale of this equation is opposite to the O of Equation (6a). It was drawn thus in anticipation of the graphical representation of Equation (5b) in which H, the product of 0.01 $O\ N_o$ is to be subtracted from 0.05M necessitating, therefore, that the H scale be graduated in the opposite direction from the M scale. The O scale for this case was marked O'.

3. Drew the skeleton representation of Equation (5b) ($0.05M - H = 0.20A$), noting that the A scale is to be graduated in the same direction as the M scale.

4. Drew the skeleton diagram of Equation (6b) ($A + O' = T$), noting that all scales are graduated in the same direction, and in the same direction as the M scale.

5. It was noted that the skeleton representation of the scales drawn thus far indicated that the T and M scales were to be graduated in the same direction. However, Equation (6c) ($M - T = W$), for which a skeleton diagram had not yet been drawn, required that the T scale be graduated in the opposite direction to M. Therefore, Equation (6c) was rewritten in the following form: $M = W + T$, for which case the skeleton representation of these scales were drawn as shown in Fig. 3.

Step V-B. Choose any convenient moduli for the two vertical scales for Equation (6a) which will represent graphically two of the variables of a

Figs. 3, 4 at left; Fig. 5, right

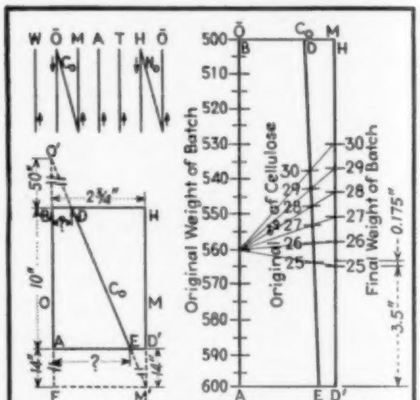
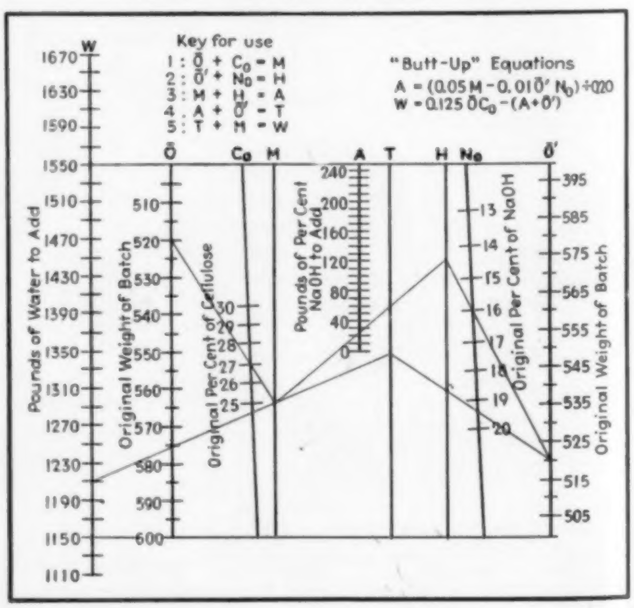


Fig. 6—Alkali cellulose butt-up chart



Type III Equation. Instead of choosing moduli, any convenient scale length can be chosen for the two vertical scales representing the variables, and from the limits of the problem, the moduli may be computed from the equations given previously.

For example it was decided to make the O scale (Equation (6a), Fig. 5 and Fig. 6) 10 in. in length. As has been shown previously the modulus of this scale was computed to be 0.10.

The modulus of the M scale was chosen after the following preliminary computations were made by substituting max and min values of O and C_o (as set by the problem) in Equation (6a):

Max limit of M scale

$$= \frac{500 \times 0.25}{0.08} = 1562.5$$

Min limit of M scale

$$= \frac{600 \times 0.30}{0.08} = 2250$$

Since it was found that the modulus of a scale of the above limits would give an inconvenient number (irrational), it was decided to set the max and min limits of a 10 in. scale for the variable M to be 1400 and 2400 respectively, this was found to give a modulus of 0.01. It should be noted, however, that actually M would vary only between 1562.5 and 2250. (Inconvenience of irrationals).

Step VI-B. Choose any convenient distance between two vertical scales which will represent graphically two of the variables of a Type III three variable equation.

The distance between the O and M scale was chosen as 2.75 in. These were represented by two parallel lines as shown in Fig. 6.

Step VII-B. Set up the equations of the scale for each of the two vertical scales (X and Z) and graduate each scale (if necessary) by the type of scale specified by this equation.

For example, the O scale, Fig. 6 was graduated by an arithmetic scale of 10 units per inch. This was previously indicated in the example given under Rule 5, concerning the equation of the scale.

Since numerical values of M were not pertinent to this problem, the M scale was not graduated but was represented by a straight line, as shown in Fig. 6.

Step VIII-B. Join the two vertical scales (X and Z scales) which were graduated in opposite directions by an oblique line which joins the zero points of each of these scales. If it is not convenient to join the oblique scale at the zero points of these two vertical scales, the oblique scale may be computed from similar triangle ratios.

This step is illustrated in Fig. 4 which is the skeleton representation of Equation (6a). Point B of scale O on this figure represents 500 lb., and point A of the same scale represents 600. The location of the zero point of the O scale was calculated from the equation of the scale as follows:

$$X = m_v (O_{500} - O_o) = 0.10 \times (500 - 0) = 50 \text{ in.}$$

Therefore, the zero point of the O scale is 50 in. above the 500 mark of this scale and this distance is indicated on the diagram.

Similarly, since the point D' represents 1400 on the M scale, and the modulus of this scale is 0.01, the zero point of this scale is 14 in. below point D' on this scale, as indicated on this diagram, Fig. 4.

From similar triangles it may be found that $BD = 1.85$ in.

Therefore the point D of the oblique scale D was located 1.85 in. to the right of point B (500) of the O scale.

From a consideration of the similar triangles $O'AE$ and $O'FM'$ it was found that point E was to be located 2.23 in. to the right of point A (600) of the O scale, or $AE = 2.23$ in.

Points D and E were ioined by a straight line. and thus the C_o scale was located.

Step IX-B. Graduate the oblique scale (Y scale) by proceeding as indicated below.

1. Choose a fixed point on the X scale (*never* the Z scale) at any convenient distance, 1, from the zero point of this scale.

2. Compute the type of graduating scale to be used by means of the following equation:

$$L = \frac{l\, m_z}{m_x} K (Y_u - Y_l)\, m_y (Y_u - Y_l) \quad (10)$$

Where K = constant of the three-variable equation (for example, Equation (6a), K = 0.125). $Y_u - Y_l$ = graduations desired on the oblique scale (for example, it was desired to graduate the C_o scale in intervals of 0.25 per cent cellulose).

Y_u, and Y_l can also be considered as upper and lower limits of the variable Y. And m_y may be considered as the modulus of the Y scale, $l\, m_z K/m_x$.

3. Locate on the Z scale (never the X scale because of mathematical nature of Type III equation) the point corresponding to the first graduation desired on the oblique scale. This may be computed by Equation (10) by allowing $Y_l = 0$; and Y_u = the first point desired on the oblique scale (for example the first point on the C_o scale was 25 per cent cellulose).

4. Graduate the Z scale temporarily with the graduating scale found by substituting appropriate values in Equation (10), and solving for L, starting with the point found in 3 above.

5. From the fixed point as a center project temporary graduations on Z scale to Y scale. This will give the graduations in the Y scale.

Scale C_o, Fig. 6, was graduated by this procedure. The detailed construction is shown in Fig. 5. The steps were as follows:

1. A fixed point was chosen at the 560 point of the O scale. Since the modulus of this scale is 0.1, the distance between the fixed point (560) and the zero of this scale is 56 in. Therefore 1 in. = 56.

2. The type of graduating scale was found by substituting the appropriate values in Equation (10).

$$m_y = l \frac{m_z}{m_x} K = \frac{56 \times 0.01}{0.1} \times 0.125 = 0.70$$

Since the C_o is to be graduated in units of 0.25 per cent cellulose, a graduating scale should be used in which the distance between each unit is $0.25 \times 0.70 = 0.175$ in. This is indicated on Fig. 5.

3. The starting point for the temporary graduations on the Z scale was computed as follows:

$$L = m_y (Y_u - Y_l) = 0.70\,(25 - 0) = 17.5 \text{ in.}$$

Since the point D on the M scale is 14 in. from the zero point of this scale,

(Please turn to page 170)

Table III. Data for Construction of Nomographic Chart for Equations (5) and (6)

Equations	Scale	Limits	Modulus	Location of Scale (in.)	Type of Graduating Scale to be Used. Remarks
Equation (6a)	O	500-600	0.10	....	Arithmetic scale 10 units per inch.
$0.125\, O\, C_o = M$	M	1400-2400	0.01	OM = 2.75*	Scale not graduated. Represented by line
(Type III)	C_o	25-30	0.70	$(OC_o)_t$ = 1.85† $(OC_o)_b$ = 2.23	Fixed point O scale at 560. Temporary graduations M scale, arithmetic scale each 0.25% C_o = 0.175 in.
$M' = 0.05\, M$ Stationary Scale	M	70-120	0.2	....	Scale not graduated. Represented by line.
Equation (5a)	O'	500-600	0.1	OO' = 10.1	Arithmetic scale. 10 units per inch.
$0.10\, O N_o = H$	H	70-120	0.2	$O'H$ = 2.75	Scale not graduated. Represented by line.
(Type III)	N_o	13-20	1.1	$(O'N_o)_t$ = 0.53 $(O'N_o)_b$ = 0.88	Fixed point O' scale at 550. Temporary graduations H scale; arithmetic scale each 0.25% N_o = 0.275 in.
Equation (5b)	M	70-120	0.2	HM = 4.6	Scale already constructed for Equation (6a)·
$0.05M - H = 0.20A$	H	70-120	0.2	HM = 4.6	Scale already constructed for Equation (5a)·
(Type I)	A	0-250	0.1	HA = 2.3	Arithmetic scale. 0.20A considered stationary scale, modulus = 0.02. Graduate scale in units of 2.5 lb. (20% NaOH). 20 units per inch of scale length.
Equation (6b)	A	0-250	0.02	$O'A$ = 5.05	Scale already constructed for Equation (5b)·
$A + O' = T$	O'	500-600	0.1	$O'A$ = 5.05	Scale already constructed for Equation (5a).
(Type I)	T	250-850	0.0166	AT = 0.85	Scale not graduated. Represented by straight line.
Equation (6c)	M	1400-2400	0.01	MT = 3.15	Scale already constructed for Equation (6a).
$M = W + T$	T	250-850	0.0166	MT = 3.15	Scale already constructed for Equation (6b).
(Type I)	W	1110-1670	0.025	MW = 4.8	Arithmetic scale. Graduate scale in units of 4 lb. 10 units per inch of scale length.

* OM = 2.75 in. represents distance between O and M scales.
† $(OC_o)_t$ = 1.85 in. represents distance between O and C_o scale at upper graduation of O scale.
$(OC_o)_b$ = 2.23 in. represents distance between O and C_o scale at lower graduation of O scale.

Building Bins of Wood and Steel

Three articles, of which this is the last, have treated a variety of bin constructions, all from the viewpoint of the plant with limited capital. Steel bins were covered in December, 1938; concrete and wood bins in January, 1939; and now, combination wood and steel bins—with the steel parts salvaged from the junk yard.

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As is clear to readers who have followed this series of articles, little space has been given to conventional designs of bins since these are ably discussed by others: notably Ketchum in his "Walls, Bins and Grain Elevators." The hope has been to aid by suggestion those engaged in developing industries of uncertain outcome from small beginnings, often with little capital available. Projects of a temporary nature may also demand the construction of bins that are not only cheap but which have a large salvage value.

In Fig. 1 is the design of a combination wood and steel bin for 50 tons of crushed limestone. On the basis of 100 lb. per cu.ft., the required volume was 1,000 cu.ft. The conical hopper, of ¼-in. steel plate was taken from a cylindrical tank 10 ft. in diameter and was obtained from a junk y rd. In the first article of this series (*Chem. & Met.*, Dec. 1938, p. 684) analysis of this hopper showed that 5/64-in. metal would satisfy the theoretical requirements. The flange was parallel with the axis of the tank so one leg of each of four short pieces of angle iron was bolted to the flange and the other legs bolted to the underside of the four 12×16-in. beams. The open fillets formed by the circular hopper and the square frame of beams were closed by 2-in. boards fitted to the periphery of the hopper and nailed to the underside of the beams. The entire load was assumed to be carried by the beams, no allowance being made for friction on the walls. The load carried by each fillet was taken as 2,500 lb. uniformly distributed over a distance of 2 ft. on the adjacent beams. The remainder of 22,500 lb. on each beam was carried by five bolts equally spaced over 3 ft.-4 in. in midspan. The variations of shear and bending moment are shown by their respective diagrams.

The allowable stress in the bolts was assumed as 16,000 lb. per sq.in. at the root of the thread, so there was required a net area of 22,500/16,000=1.4 sq.in. The area at the root of the thread of a ¾-in. bolt is 0.302 in., so the required number was 1.4/0.302=5 bolts.

The maximum bending moment in the beam was in midspan and was found as follows: Moment of reaction about midspan = 12,500×62= +775,000 in.lb.; moment of one-half midspan load about midspan=11,250 ×10=112,500 in.lb.; moment of end load about midspan=1,250×50= —62,500 in.lb.; net bending moment = +600,000 in.lb.

Assuming a width of beam of 12 in., and deducting ¾ in. for the bolt holes, we had a net width of 11¼ in. With an allowable fiber stress of 1,200 lb. per sq.in., the section modulus was 600,000/1,200=500 in.^{3}, and the required depth of beam was $(6\times500/11.25)^{\frac{1}{2}}=16.33$ in. Making the beam 16 in. deep increased the fiber stress only about 4 per cent; and since there was a compensating factor in the attachment of the beam and wall, the 16-in. beam was satisfactory. If it were certain that there would be firm contact between the bottom of the beam and the flange of the hopper, the beam could safely be designed for the moment at the outermost bolt hole. But such refinement of design has little practical significance; especially since the beam forms a part of the wooden wall above the hopper, and increasing its depth is partly compensated by the saving of material in the wall above the beam. Furthermore, one cannot be certain that there would always be firm contact between flange and beam since shrinkage would cause a separation of the two. The ends of the beam were half-lapped and fastened to the posts with 1-in. drift bolts driven into ⅞-in. holes. The posts were 10×10 in. and the bearing pressure for a total load of 105,000 lb. was 105,000/(4×10×10)=262 lb. per sq.in., which was well within the safe stress perpendicular to the fibers.

The height of the walls above the beam was 7 ft., and leveling the 3-ft. surcharge to its average of 1 ft., we had a height, or head, of material of 8 ft. Assuming the pressure of a liquid weighing 25 lb. per cu.ft., the resultant lateral pressure was $P=8^2\times25/2=800$ lb. per ft. of width. The unit lateral pressure at the bottom of the wall was 8×25= 200 lb. per sq.ft., and the pressure at the 7-ft. level was 800×2/7—200 =28.5 lb. per sq.ft. The position of the resultant was at the center of gravity of the pressure diagram 31.5 in. above its base. The upper reaction was then 800×31.5/84=300 lb., and the lower reaction 800—300= 500 lb. The maximum bending moment was found by taking moments about the position of zero shear and was 8,570 in.lb.

The above method is a bit cumbersome so, in view of the fact that the position and magnitude of the resultant of the horizontal forces cannot be determined exactly, we might use the following method: Referring

to the triangle representing the pressure for the 8-ft. height, we find the magnitude of 800 lb. and the position of the resultant at one-third the height, or 32 in. Using the actual span of 7 ft., the upper reaction is $800 \times 32/84 = 305$ lb., and the lower reaction, by subtraction, 495 lb. The bending moment may be found by the formula for triangular loading, using the load corresponding to the depth of 8 ft., but the actual span of 7 ft., or $0.128Wl$ which, for the present case would be $0.128 \times 800 \times 84 = 8{,}600$ in. lb. per ft. width of bin; which is very close to the 8,570 in.lb. found by the first method.

Using the moment found by the latter method, a fiber stress of 1,200 lb. per sq.in., and 2×6-in. studs, their spacing was $2 \times 6^2 \times 1{,}200/6 \times 8{,}600 = 1.675$ ft., or 20 in. In the present case this would have lead to 5.5 spaces so we used 6 spaces of 18.33 in.

The shear at the lower end of each stud was $495 \times 18.33/12 = 756$ lb. Two 30d nails "toenailed" through the end of a stud and into the beam, and two more nails in the 2×4-in. end-block had resistance of 960 lb. so were satisfactory. The shear at the upper end of each stud was $305 \times 18.33/12 = 466$ lb., for which two 30d nails were ample.

The 2×10-in. plate on the upper ends of the studs was a beam with a uniformly distributed load of 305 lb. per ft. Assuming a span of 9.5 ft., the bending moment was $305 \times 9.5^2 \times 12/8 = 41{,}300$ in.lb., and the fiber stress $41{,}300 \times 6/(2 \times 10^2) = 1{,}240$ lb. per sq.in. Due to the fact that the wall planks were partially restrained, the total load as found above did not reach the plate. And as no account was taken of the added resistance afforded by the plate being nailed to the top plank of the bin lining, the actual stress was much less than the allowable 1,200 lb. per sq.in.

Considering the plate as a simple beam, the load transmitted to a reaction was 1,220 lb., requiring $1{,}220/320 = 4.8$, say five 40d nails. Since a 6-in. stud could not properly accommodate five nails the corner studs were made 2×8-in. as shown.

In addition to the vertical load as found in the foregoing, the 12×16-in. beams were subjected to a lateral load represented by the lower reactions of the studs, plus the pressure on the sides of the beams, or 720 lb. per ft. The hopper, acting as a tie, was ample resistance, but if it did not exist, and the load of 720 lb. were applied to the length of the beam, there would be a stress of $720 \times 10^2 \times 12 \times 6/(8 \times 16 \times 12^2) = 281$ lb. per sq.in. added to the stress in the upper inside corners and the outside lower corners of the beams, which stresses would be subtracted from the other corners.

Use for Old Chimneys

In Fig. 2 is a bin, the hopper of which was made of four semi-circular sections, taken from two 5-ft.-long rings of a 10-ft. diameter steel chimney. The plate was ¼ in. thick, rusty and contained a number of small holes, but was satisfactory for the purpose of a bin for storing crushed stone. Each ring was made of four sheets and, as each ring was tapered—that is, the upper end of each ring of the chimney was inserted into the lower end of the ring above, both the sheets and spacing of the rivet holes were identical. The girt seam rivets were on 3-in. centers, and the longitudinal rivets on 4-in. centers. To the upper edges of the hopper we riveted 4×3×½-in. angles for attachment to the wood beams. The ends of the hopper were closed with planks bolted to flanges formed in the ends of the hopper, and to the posts. The hopper was

Fig. 1—Wood-steel bin with a conical hopper bottom

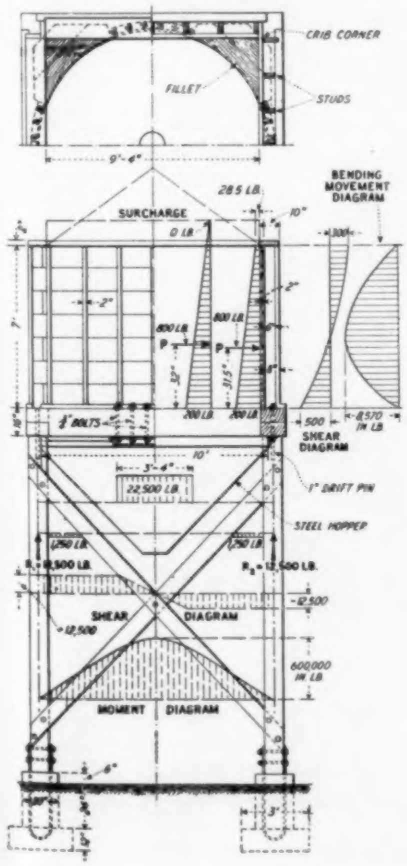
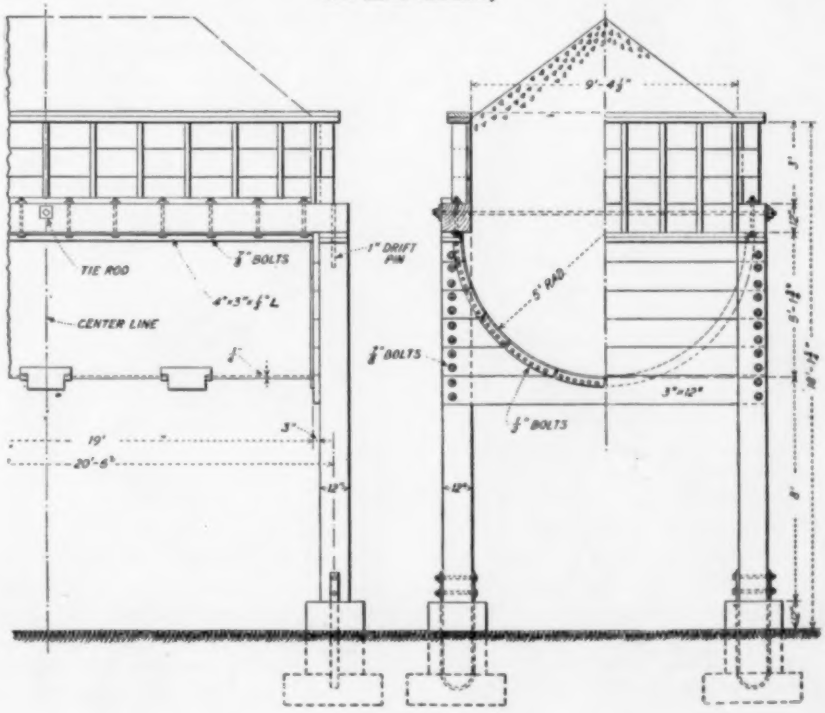


Fig. 2—Wood-steel bin with the semi-cylindrical steel bottom made from an old steel chimney



assumed to act as a beam, resisting the transverse stresses, while the wood beams and end construction carried the vertical shear. The desired capacity of the bin was a minimum of 80 tons.

The middle transverse (girt) joint of the hopper was subject to the maximum bending moment and determined the strength of the hopper. Calculation disclosed that the nominal size of rivet, ½-in., would not be adequate, so the rivets were driven hot to insure complete filling of the holes, which produced rivets of 9/16-in. diameter. All other rivets were driven cold since they were of less importance.

Hopper Safe for the Load

Reducing the area of the rivets to an equivalent area of plate, it was found to be $0.2485/3=0.0828$ in. thick. Combined with the flange angles, the moment of inertia of the section was 12,400 in.^{4}, and the lesser of the two values of the section modulus was 367 in.^{3}. With an allowable shearing stress of 12,000 lb. per sq.in., the resisting moment was $367\times 12{,}000=4{,}400{,}000$ in.lb., and the allowable load on a 19-ft. span was $8\times 4{,}400{,}000/(19\times 12)=154{,}000$ lb. No account was taken of the effect of the wood beams on moment. At this point in the calculations it became evident that 85 tons capacity could be readily obtained. Deducting 154,000 lb. from 170,000 lb., there was left 16,000 lb. (or 8,000 lb. to be carried by each end). That the six 3-in. × 12-in. planks could carry this load was obvious and needed no calculation; but it was deemed advisable to check the capacity of the ½-in. bolts fastening the end walls to the bin.

The angles were riveted to the edges of the hopper with ½-in. rivets in the existing holes in the plate, and which were on 4-in. centers. The load per lineal foot of sides was $154{,}000/(2\times 9)=4{,}050$ lb., and the shearing stress in the rivets was $4{,}050/3\times 0.1963=6{,}870$ lb. per sq.in., based on their nominal size.

The ends of the hopper were split at intervals determined by the joints between planks, and were hammered out to form flanges about 3½ in. wide to which the planks were bolted. The wide flanges were necessary to accommodate the drill, since boring was done from the bin side of the flanges.

Tests by Dewell on bolted wood fish-plate splices in which the fish-plates were one-half the thickness of the main member, and with the bolt pressure acting with the grain of the wood, proved that a satisfactory assumption for the moment arm is the sum of one-half the thickness of the fish-plate and one-fourth the thickness of the main member, the resulting moment formula being $M=P(t'/2+t''/4)$. The formula also applies to cases like the present one in which the fish-plate is thin steel plate. In the case of the bolt pressure acting perpendicular to the grain as in the present case, the moment is increased 60 per cent, or $M=1.6\ P(t'/2+t''/4)$. The resisting moment of a ½-in. bolt with a fiber stress of 16,000 lb. per sq.in. is $0.098\times 0.5^3\times 16{,}000=196$ in.lb. The thickness of the plate, t', was ¼ in., and of the main member, t'', was 3 in. Solving for the resistance of one bolt we had $P=196/(1.6\times 0.75)=163$ lb. And to carry the 8,000 lb. allotted to each end of the bin there were required $8{,}000/163=49$ bolts. There were actually placed 56 bolts and lag screws.

A load of 80,000 lb. was assumed to be transmitted to each beam, so with ⅞-in. bolts and a stress of 16,000 lb. per sq.in. at the root of the thread, there was required $80{,}000/(0.42\times 16{,}000)=12$ bolts. Washers of 4½ × 4½ × ½-in. steel held the bearing pressure under 350 lb. per sq.in. and the stress in the washer at about 20,000 lb. per sq.in.

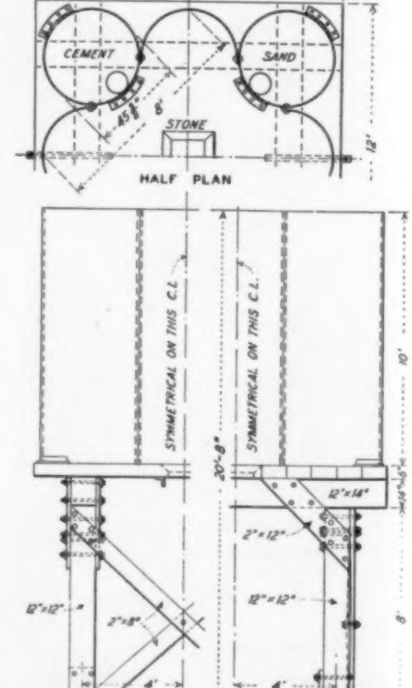
Riveting of the hopper and the angles, and bolting of the ends, was done on the ground. Then the hopper was raised into position and bolted to the beams. The holes in the end planks and posts were bored in a single operation so there was no trouble fitting these. The required thickness of planks was found to be between 2 and 2½ in., but some rough 3-in. planks that had been used in unloading machinery for the plant were used.

The size and number of bolts holding the end planks to the posts were determined in the manner described in the foregoing, with the exception that since the main member, a 12-in. post, was larger than contemplated by the formula, a member twice the thickness of the plank, or 6 in., was assumed. A load of 4,000 lb. was carried to each post, so with six planks and two bolts per plank, the load P on each bolt was 333 lb. The moment arm was $3/2+6/4=3$ in., and the bending moment was $333\times 3=999$ in. lb. With a fiber stress of 16,000 lb. per sq.in., the required section modulus was $999/16{,}000=0.0624$ in.^{3}, and the diameter was $(0.0624/0.098)^{1/3}=0.86$ in., say ⅞ in.

The beams carried the vertical load, but not the corresponding bending moment since that was carried by the bin itself. The 12×12-in. beams and posts were chosen to keep the bearing pressure on the beam (perpendicular to the grain), within a safe limit. This pressure was $40{,}000/12^2=278$ lb. per sq.in. When the bearing pressure on a wood beam is within the allowable limit, the shears are also safe except for very short beams. Assuming a moment arm of 8 in., the bending moment at the first bolt hole was $40{,}000\times 8=320{,}000$ in.lb. and the fiber stress was $320{,}000\times 6/(11.125\times 12^2)=1{,}200$ lb. per sq.in. i.e., the accepted value.

Assuming a depth of 10 ft., and a lateral pressure of a liquid weighing 25 lb. per cu.ft., the pressure on the sides of the beam was $10^2\times 25/2=1{,}250$ lb. per ft., and the point of application of its resultant P was 10/3 ft. above the base of a triangle representing the load. The beam was 5.5 ft. above the base of this triangle, so the load on the beam was

Fig. 3—Cellular bin for stone, sand and cement made from steel chimney parts



$1{,}250 \times 3.33/5.5 = 757$ lb. per ft. A tie rod passing through the beams at the center and spanning the bin would carry ⅝ of the total lateral load on a side of the bin, or $757 \times 19 \times 5/8 = 9{,}000$ lb. With an allowable stress of 16,000 lb. per sq.in., the area at the root of the thread was $9{,}000/16{,}000 = 0.562$ sq.in., corresponding closely to that of a 1-in. bolt, which was used. The walls above the beams were built similar to those of Fig. 1 as being the minimum of practical requirements. Post bracing, not being essential because of the rigid attachment of bin and posts, was omitted, thus permitting trucks to pass under.

Another Chimney Bin

Fig. 3 shows a bin, a portion of a concrete mixing plant, also made from an old steel chimney. This chimney was made up of six 10-ft.-long rings of 8-gage steel. Having been rolled from 12-ft. sheets, it was a little more than 45 in. in diameter. A study disclosed that by the arrangement shown in the plan, we would have one cell for cement, three for sand and the equivalent of six cells in the compartment for crushed stone. As the concrete work consisted in foundations for buildings and machinery, extending over a considerable area, the bin support terminated at the bottom in a pair of skids to permit dragging the bin to convenient centers of operation. These centers were within reach of the boom of a locomotive crane which, with its grab bucket, unloaded cars to bin or storage, or recovered from storage to bin.

The chimney rings had a single riveted longitudinal seam with ⅜-in. rivets on 2½-in. centers. By splitting two of the rings with a torch four semi-circular sections were produced. The punched edges of the semi-circular sections were then used as templates for drilling holes in the circular sections; and the holes in the circular sections served the same purpose for the semi-circular sections. Only half the original number of rivets was used; that is, rivets were driven into every other hole of the original spacing. The $3 \times 3 \times 5/16$-in. angle base ring was cut up into eight pieces and riveted to the bottom edges of the sections for bolting to the platform. The tops of the skids were planked over to support the mixer; and four grillages of two layers of 6 in.×12 in.×3-ft. timbers were set in the ground under each post to distribute the load on the soil. The cement, sand and stone to the mixer were measured by means of two gates in each spout, the space between gates having the required volume. Opening the lower gate discharged the material to the mixer; then closing the lower gate and opening the upper one filled the space for the next batch.

With a depth of 10 ft. and the 25-lb. liquid pressure, the resultant lateral pressure was $10^2 \times 25/2 = 1{,}250$ lb. per ft. of length and, for the width of the diagonal between the middles of two adjacent semi-circles, or 8 ft., the total pressure was $8 \times 1{,}250 = 10{,}000$ lb. With the cells empty and the stone compartment full, the horizontal thrust and the overturning moment would have to be borne entirely by the holding-down bolts.

In building this bin the bending moment in the bolts was not considered. It was assumed that the horizontal force was resisted by the friction between the base angles and the platform. With a coefficient of friction of 0.5 and a tensile stress of 16,000 lb. per sq.in. in the bolts, their sectional area was $10{,}000/(0.5 \times 16{,}000) = 1.25$ sq.in., so the eight ¾-in. bolts with a net area of 2.4 sq.in. provided ample safety against horizontal displacement.

The horizontal force P was assumed to act at one-third the height above the bottom of the cells, or $10 \times 12/3 = 40$ in. The overturning moment on the assumed area was then $40 \times 10{,}000 = 400{,}000$ in.lb. The distance between the bolts and the center of the compression area was about 48 in., so the tensile force in the bolts and the compression under the opposite bearing angle was $400{,}000/48 = 8{,}333$ lb. The tensile stress in the four ¾-in. bolts was then $8{,}333/(4 \times 0.302) = 7{,}000$ lb. per sq.in., which was very moderate. The bearing angles were one-eighth of the circle making up the original base ring and had an area of about 57 sq.in., so the bearing pressure caused by the moment was only $8{,}333/57 = 146$ lb. per sq.in. With the assumed maximum load conditions and impending lift at the inner angles, the pressure under the outer angles would be that required to resist the thrust or the overturning moment, whichever was the larger. As the horizontal thrust was 10,000 lb. and the assumed coefficient of friction was 0.5, there was required a vertical force of $10{,}000/0.5 = 20{,}000$ lb. The pressure produced by the moment was only 8,333 lb. Dividing the vertical force by the area of the angle, the pressure on the platform timbers was $20{,}000/57 = 350$ lb. per sq.in., which was satisfactory.

In the design of the platform a uniformly distributed load of 1,000 lb. per sq.ft. on an 8-ft. span was assumed. Using the formula for a simple beam, $Wl^2/8$, the bending moment in a 12-in. width was $1{,}000 \times 8^2 \times 12/8 = 96{,}000$ in.lb.; and with a fiber stress of 1,200 lb. per sq.in., the required depth was $(96{,}000 \times 6/12 \times 12{,}000)^{\frac{1}{2}} = 6.32$ in. Since there was partial restraint due to the overhanging ends, 6-in. wood was used.

The beams were assumed to carry the load on a 5×8-ft. area, or 40,000 lb. Designed as a simple beam, the moment was $40{,}000 \times 8 \times 12/8 = 480{,}000$ in.lb. With a 12-in. width and a fiber stress of 1,200 lb. per sq.in., the depth was $(480{,}000 \times 6/12 \times 12{,}000)^{\frac{1}{2}} = 14.14$ in. Since there was a substantial reduction of the moment due to the overhang, 14-in. timbers were used. No formal effort was made to reinforce the opening for the spout in the stone compartment, but two heavy steel angles 5 ft. long were used to bolt the spout to the underside of the platform, arranged so as to transfer the load on the free ends of the timbers to adjacent ones.

Useful Discards

Anyone contemplating the construction of cheap hopper-bottomed bins would do well to consider the tanks found in junk yards. Having outlived their usefulness in the service for which they were built, and often rusted through in spots, they still are capable of years of service in small bins of the kind discussed in these articles. A tank with "bumped" heads, split along the middle, will provide two hoppers almost ideal in shape; and the required capacity may be had by building up the sides as shown in Fig. 2. Whatever the limiting factors may be, the thickness of the plate will not be one of them.

Suppose that the tank were 10 ft. in diameter and of ¼-in. plate and that the rivet holes, or rust-thinned areas, reduce the section one-half. The net sectional area would be $0.25 \times 12/2 = 1.5$ sq.in. per ft., requiring for its support 1⅝-in. bolts on 12-in. centers. To develop the strength of this hopper in a crushed stone bin, the depth of stone would have to be $1.5 \times 16{,}000/5 \times 100 = 48$ ft.

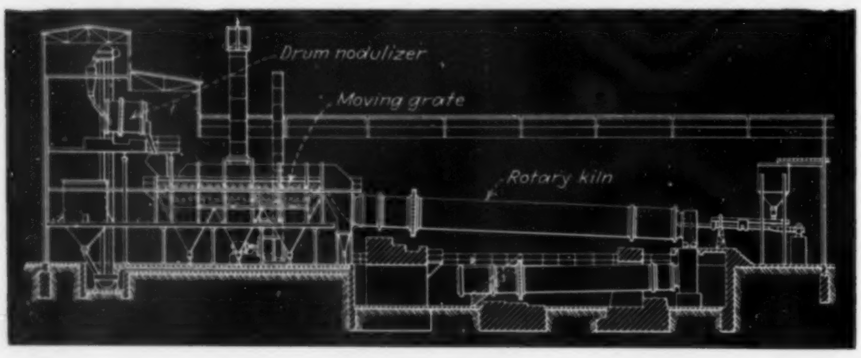
Portland Cement Process

Unique among the cement plants of the United States is that of the Spokane Portland Cement Co. at Irvin, Wash., where a Lepol kiln has been installed. This kiln recovers both heat and dust from the waste gases. There are said to be many installations in Europe, but this is the only one in the United States. A second installation is scheduled for a Pacific Coast plant soon.

In the Lepol system (see drawing), the finely powdered raw material passes into a "nodulizer" which is a short rotating drum. As the powder is carried around, it is sprayed with water from a spray pipe and forms into small nodules or balls. These drop out of the drum into a hopper which feeds them onto a traveling grate. The grate chamber is connected directly to the end of the kiln. The hot kiln gases pass up through the grate around the nodules, through an exhaust fan and out of the stack. A small amount of the material naturally falls through the grate, but this is collected in a bin and is carried back to the nodulizer.

The heated nodules drop into the kiln and proceed through the remainder of the cement making process in the usual manner. Inasmuch as the gases leave the kiln at about 250 deg. F., it is clear that considerable heat economy is attained. The system makes for increased kiln capacity and there is very little dust left in the stack gases. The heat recovered is considerable since the nodulized material averages but 12 to 13 per cent of water. Operations in a number of European plants have shown a heat consumption varying from about 585,000 to 680,000 B.t.u. per bbl. of cement.

Lepol cement kiln used by Spokane Portland Cement Co. at Irvin, Wash.



Butt-Up Charts

(Continued from page 165)

25 on the M scale is therefore 3.5 in. from D', as indicated on Fig. 5.

4. The M scale was graduated temporarily with a graduating scale in which each unit was 0.175 in. starting at 25 per cent and ending at 30 per cent cellulose.

5. The temporary graduations on the M scale were projected onto the C_o scale from the fixed point located at 560 on the O scale. The details of construction are shown in Fig. 5.

6. The construction and temporary lines were erased and the final graphical representation of Equation (6a) is shown as scales O, C_o, and M, Fig. 6.

Step X-B. Construction of scales for Equation (5a). The line representing the O' scale was drawn at an arbitrary distance of 10 in. from the O scale. The steps in the construction of the three scales, O', N_o, and H were the same as for the construction of the previous illustration and as given in Steps V-B to IX-B inclusive. The data for the construction of the chart for this equation and those which follow are given in Table III.

Step XI-B. Construction of scales for Equation (5b). Since the M and H scales were already located, the position of the A scale (corresponding to Z scale of Type I equation) was located according to the rules for a Type I chart. However, it will be noted that the modulus of the M scale had to be modified in this case since in Equation (6a) M represents the final weight of the batch of the mixture after butting-up, while in the case of Equation (5b), it represents the pounds of NaOH in the final batch, the two quantities differing only by the constant 0.05. As was pointed out before, such a relationship may be represented by a stationary scale having two different moduli. The modulus of M for Equation (6a) was found to be 0.01; the modulus of the M scale for Equation (5b) is $0.01/0.05 = 0.20$.

The A scale was graduated by the procedure indicated previously, Step XIII-A, in graduating the I scale.

Step XII-B. Construction of scales for Equation (6b). This again was considered a Type I equation. Since the A and O' scales were already located, and their moduli already fixed, the location of the T scale was set and was located according to the rules given under Step X-A.

Step XIII-B. Construction of scales for Equation (6c). This again was considered a Type I equation. Since the M and T scales were already located, and their moduli fixed, the T scale was located according to the rules given under Step X-A. The W scale was graduated by the procedure indicated under Step XIII-A.

The construction of the chart for Equations (5) and (6) was thus completed and is shown in its final form in Fig. 6.

Application of Alkali-Cellulose Butt-up Chart

Consider the following typical problem:

A 520-lb. batch of cellulose xanthate ("alkali-cellulose") contained 16 per cent NaOH and 27 per cent cellulose. How much water and 20 per cent NaOH must be added to this batch in order to produce viscose containing 5 per cent NaOH and 8 per cent cellulose by weight?

Solution by Nomograph—Graphical solution by the nomograph is shown by dash line construction in Fig. 6. The steps in the graphical procedure were as follows:

1. Joined 520 (O' scale) and 27 (C_o scale) with a straight line and marked its point of intersection m on the M scale.
2. Joined 520 (O') scale and 16 (N scale) with a straight line and marked its point of intersection h on the H scale.
3. Joined h (H scale) and m (M scale) with a straight line and marked its point of intersection 22.25 on the A scale. This represents the pounds of 20 per cent NaOH to be added.
4. Joined 22.25 (A scale) and 520 (O') scale with a straight line and marked its point of intersection t (T scale).
5. Joined t (T scale) and m (M scale) with a straight line and marked its point of intersection 1,210 on the W scale. This point represents the pounds of water to be added.

Therefore, add 22.25 pounds of 20 per cent NaOH and 1,210 lb. of water to 520 lb. of cellulose xanthate.

New Titles, Editions and Authors

NOMOGRAPHICS

THE CONSTRUCTION OF NOMOGRAPHIC CHARTS. By *F. T. Mavis.* Published by the International Textbook Co., Scranton, Pa. 132 pages. Price, $2.

Reviewed by *D. S. Davis*

GROWING OUT of a course in graphical and numerical methods offered at the University of Iowa, Mavis's scholarly textbook is an outstanding example of the determinant treatment as applied to the construction of alignment charts. He has wisely included an appendix which summarizes pertinent information as to matrices and third-order determinants for the benefit of those who may be a little hazy on these subjects. The preliminary discussion of the slide rule, logarithms and functional coordinate papers is particularly valuable and likely to lure the reader into the succeeding chapters.

The illustrative problems, in no way academic, are drawn from the fields of mechanical and civil engineering and are solved in gratifying detail. Additional, unsolved examples might be considered by some to be needed yet many instructors would prefer to supplement any text with problems from their own fields.

Considerable study would appear to be required before one could apply the methods of this text but any major advantages in the determinant approach over other methods could hardly escape the careful student who succeeded in mastering this presentation.

CHEMICAL ECONOMICS

THE ECONOMICS OF CHEMICAL INDUSTRIES. By *Edward H. Hempel.* Published by John Wiley & Sons, New York, N. Y. 259 pages. Price, $3.

Reviewed by *S. D. Kirkpatrick*

DR. HEMPEL FEELS, with some justification, that training in the economics of chemical industry should not be confined to chemical engineers. He noted the need for a text that could be used by business men who were not called upon "to solve primarily technical problems in their daily work." His teaching experience in extension courses at Columbia University revealed many chemists without engineering training who wished to study the characteristic background and the economics common to the American chemical industries. This book was written primarily to serve these two needs and hence no attempt has been made to tie economics directly in with chemical engineering.

The author has done a thoroughly comprehensive job. His statistical analyses of chemical industry, most of which go back to the middle of the last century, are without doubt the best and most valuable features of his work. He derives certain unique factors of wealth creation that are worthy of careful study by all who are concerned with the economic virility of this group of industries.

His historical material is less intimate than that given by Haynes in "Chemical Economics" nor has he approached production and marketing from the same practical viewpoint as Tyler in "Chemical Engineering Economics." Yet the broad background of this careful student of industrial economics and management is evident throughout this book and makes it especially valuable as a sympathetic outsider's views of the insider's many problems. As such, this reviewer heartily recommends it to all who seek "the systematic and fundamental preparation which is necessary for the proper understanding, appraising and solving of chemical economic problems."

PULP and PAPER, V

THE MANUFACTURE OF PULP AND PAPER. Third Edition, Vol. 5, PAPERMAKING MACHINES; HANDMADE PAPERS; PAPER FINISHING; COATED PAPERS; PAPER TESTING; PAPERMAKING DETAILS. Edited by *J. N. Stephenson.* Published by McGraw-Hill Book Co., New York, N. Y., 1939. 750 pages. Price, $6.50.

Reviewed by *James A. Lee*

THE MANY CHANGES which were found necessary in the revision of this volume indicate the great advances that have been made in the paper industry during the past ten years. For the benefit of those engineers who are acquainted with last edition, special attention is directed to the following features: The section on paper making machines embodies descriptions of new head box designs, a new method of installing the wire, a new press part, a new electric drive, an additional chapter on insulating boards, and new designs of cylinder machines. Extensive changes have been made in the text on handmade papers and in papermaking details. The sections on coated papers and paper testing have been rewritten.

To the unitiated it might be advisable to point out that these volumes dealing with the manufacture of pulp and papermaking are an official work prepared under the direction of the Joint Textbook Committee of the paper industries of the United States and Canada. The various phases of modern pulp and paper mill practice are covered by the leading authorities in the two countries. In recognition of the splendid manner in which the work has been edited the Technical Association of the Pulp and Paper Industry recently awarded Mr. Stephenson its highest honor, the T.A.P.P.I. medal.

FRENCH SOAP MAKING

MANUEL DU SAVONNIER. By *A. Matagrin.* Published by Gauthier-Villars, Paris, France, 1938. 268 pages. Price, 30 francs.

Reviewed by *W. L. Abramowitz*

THIS FRENCH HANDBOOK, according to its index, covers a great many phases of soaps and soap making, but in its pages does not disclose very much advanced art not available in as good or better format in English. Among some of the more important aspects considered are the physical and chemical principles of saponification, composition of the fats, oils and fatty acids used, various manufacturing practices, industrial, toilet and medicinal soaps, perfuming, coloring and preservation of soaps.

The book might be of some use as a quick reference tool or to students who wish to learn French and the fundamentals of soapmaking at the same time.

ARCHITECTURE OF THE EARTH. By *Reginald Aldworth Daly.* Published by D. Appleton-Century Co., New York, N. Y., 1938. 211 pages. Price, $3.00.

THIS IS ONE of the "Century Earth Science Series." Although intended primarily as a text in geology and geophysics for college students the data herein presented are of such a nature that it may be read and understood by

the intelligent layman. However, this book is of merit as a text rather than as a popular book because it is in technical language. The material covered includes a study of the composition of the earth and the effects of outside forces on the terrestrial sphere, thus touching a bit on the field of astronomy.

UNDERGROUND CORROSION

PIPE CORROSION AND COATINGS. By *Erick Larson* with a chapter on Cathodic Protection by *George I. Rhodes*. Published by American Gas Journal, Inc., 1938. 455 pages. Price, $2.50.

Reviewed by *E. S. Johnson*

IN THIS first edition the author's presentation is a timely effort to contribute ripe experience in an effort to salvage a portion of the yearly ravages of corrosion in industry on piping and metallic structures. It is estimated that an aggregate deterioration of up to $100,000,000 in the United States occurs yearly.—A corps of experts has supported Mr. Larson.

Theories as to causes—chemical action, electrolysis, stray currents, and soil conditions inducing these effects—are elaborately set forth as becomes their significance. Compensating mitigation, or elimination to a minimum is given thoroughly practical discussion. This begins with laboratory tests: Acidity of soil, moisture conditions, and electric characteristics are determined. Direct corrosion tests are advised. An important device to this end is that of Corfield the "Nipple and Can Test". Advisibility of a corrosion survey is emphasized. Pipe cleaning and protective coatings are reviewed in a style evidencing expert foundation. The book is well illustrated; a practical manual. The special chapter on Cathodic Protection justifies the 30 pages devoted to the subject—The publisher's work is well executed.

BIG STEEL'S METHODS

SAMPLING AND ANALYSIS OF CARBON AND ALLOY STEELS. Methods of the Chemists of the Subsidiaries of the United States Steel Corp. Published by Reinhold Publishing Co., New York, N. Y. 355 pages. Price, $4.50.

Reviewed by *Edward S. Johnson*

THE AUTHORSHIP indicated in the title of this book vouches from the start for thorough-going presentation of the subject. The reader is not to be disappointed. Only those who have had to do intimately with steel analysis are fully alive to the precautions imperative to secure in the form of a small test-ingot a sample which shall adequately represent the tons of molten metal drawn, for instance, from one of the present-day open-hearth steel furnaces. The metal in the form of bar, plate or what not is destined of course to be sold on rigid specifications as to chemical composition. The specifications must be met. The precautions to this end are abundantly and clearly detailed by the authors.

WHY AND HOW OF LUBRICATION

THE PRINCIPLES AND PRACTICE OF LUBRICATION. Second Edition, Revised. By *A. W. Nash* and *A. R. Bowen*. Distributed by Chemical Publishing Co., Inc., New York, N. Y., 1937. 345 pages. Price, $7.25.

Reviewed by *M. E. Clark*

THE AUTHORS, both eminent English petroleum technologists, describe English and American practice in the measurement of various properties of lubricants, methods of application, design and lubrication of bearings and, most important of all, industrial lubrication practice. In addition they deal with the types and kinds of friction, the chemistry of lubricants, sources of raw materials and methods of refining, methods of testing and, finally, the care and recovery of oils.

In the chapter on industrial practice, specific lubricating problems are discussed, such as those involved in airplane engines, motor vehicles, diesel and steam engines, turbines, power transmission equipment, boiler plant accessories, steel works equipment, machine tools and other miscellaneous tools.

The newer developments in the field, such as extreme pressure lubrication, have been adequately treated. A 20-page appendix of pertinent charts and tables also adds to the usefulness of the text. All in all, the entire volume might well be termed a manual on the what, where, when, why and how of lubrication.

ENGLISH and GERMAN

ENGLISH FOR STUDENTS IN APPLIED SCIENCES. By *S. A. Harbarger, W. R. Dumble, W. R. Hildreth,* and *Bert Elmsley*. Published by McGraw-Hill Book Co., Inc., New York, N. Y., 1938. Price, $2.00

Reviewed by *F. J. Kohlins*

WHEN THE STUDENT or worker in the realm of science has occasion to present material that he has developed he seldom has need of a fine literary or poetic style, but must give a clear, concise, accurate, and to-the-point report. Like a nut meat, clear and free of a cumbersome shell, the scientific work must be put into words, conducive to unhampered thinking. This book seems to give to a student of the sciences a tool for acquiring just this clarity and conciseness. The illustrative and practice material has been taken directly from standard technical works, and, in addition it deals individually with the presentation of oral reports, long papers, and summaries. There is a brief bibliography attached which includes books in various fields of science.

This work is also valuable for the English teacher who must deal with the scientific student and give him those parts of rhetoric and composition most useful as tools for future application in the pursuit of his scientific career.

GERMAN GRAMMAR FOR CHEMISTS AND OTHER SCIENCE STUDENTS. By *J. T. Fotos* and *J. L. Bray*. Published by John Wiley and Sons, Inc., New York, 1938. 323 pages. Price, $2.25.

UNTIL RECENTLY a large percentage of all technical literature was written in German. A knowledge of German as a literature does not enable the scientific worker to read technical German because of the immense vocabulary involved. On the other hand, several years are necessary to master the German language as a literary tool and many scientific students do not feel they can devote this much time to its study. Therefore, this particular book seems to play an important part in the education of a technical worker. This worker armed with this text, plus a good dictionary should be able to handle most of the German chemical literature.

MINERALS

THE MINERAL INDUSTRY DURING 1937, VOL. 46. Edited by *G. A. Roush*. Published by McGraw-Hill Book Co., Inc., New York, N. Y., 1938. 778 pages. Price, $12.

IN 1937, with every branch of mineral production showing impressive gains over 1936, the total world figure for this industry pushed through its 1929 peak for the first time. Only coal, pig iron, and lead out of a list of 25 major mineral commodities failed to set new all-time highs. Particularly large increases were recorded for aluminum, chromium, gold, manganese, petroleum and tungsten.

Such is a small sample of the facts and figures contained in this new edition of The Mineral Industry. The volume keeps the same arrangement, scope and high quality of information that have characterized its predecessors.

LEXICON OF GEOLOGIC NAMES OF THE UNITED STATES. A two-volume publication of the U. S. Geological Survey. Compiled by *M. Grace Wilmarth*. Published as U. S. Geological Survey Bulletin 896. Available only from the Superintendent of Documents, Government Printing Office, Washington, D. C. 2396 pages. Price, $2.50 per set (paper bound).

EVERYONE HAVING any problems in the fields of mineralogy, geology, or related science or industry will find this two-volume set an invaluable reference document. It should not be regarded as a dictionary, however, since the descriptive material is more of a geologic interpretation with references to major uses of the terms defined. Furthermore, one should not expect to find in these volumes any description of composition or properties of minerals and rocks. Anyone desiring this latter type of information should depend upon the older publications of the Survey which still remain the most authoritative reference texts on those subjects.

A TEXTBOOK OF BIOCHEMISTRY. By *R. J. Williams*. Published by D. Van Nostrand Co., New York, N. Y., 1938. 525 pages. Price, $6.00.

ACCORDING TO the author's statement this book has been written as a text "suitable for medical students and others with similar interests." This work takes the fundamental material of biochemistry and logically arranges it according to more or less chronological funcions: 1. Biochemical materials; 2. Tissue composition; 3. Food composition; 4. Bodily mechanism changes and 5. Metabolism.

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.

Motor Fuels from Farm Products, by P. Burke Jacobs and Harry P. Newton. U. S. Department of Agriculture, Miscellaneous Publication No. 327; 15 cents.

Stored-Grain Pests, by E. A. Back and R. T. Cotton. U. S. Department of Agriculture, Farmers' Bulletin No. 1260; 10 cents.

Timber Requirements of the Hardwood Distillation Industry, by M. H. Haertel. Progress report of The Forest Survey, conducted by Forest Service, U. S. Department of Agriculture; mimeographed.

Testing Wood Preservatives. Available only from Forest Products Laboratory, Madison, Wis.; mimeographed.

Forest Products Statistics. Two documents of the Department of Agriculture are: Forest Products Statistics of the Pacific Coast States. Statistical Bulletin No. 65; 10 cents; Forest Resources of Northeastern Florida, by F. A. Ineson and I. F. Eldredge. Miscellaneous Publication No. 313; 20 cents.

Effect of Potash on Grade, Shape, and Yield of Certain Varieties of Sweetpotatoes Grown in South Carolina; by Victor R. Boswell, J. H. Beattie, and J. D. McCowan. U. S. Department of Agriculture, Circular No. 498; 5 cents.

Symptoms on Field-Grown Tobacco Characteristic of the Deficient Supply of Each of Several Essential Chemical Elements, by J. E. McMurtrey, Jr. U. S. Department of Agriculture, Technical Bulletin No. 612; 10 cents.

Home Mixing of Fertilizers, by C. C. Fletcher and Albert R. Merz. U. S. Department of Agriculture, Leaflet No. 70; 5 cents.

Control of Insects Attacking Grain in Farm Storage, by R. T. Cotton. Includes recommendations about certain chemicals. U. S. Department of Agriculture, Farmers' Bulletin No. 1811; 5 cents.

Developments in Mechanical Equipment and Methods in Sugar-Beet Production, by E. M. Mervine and S. W. McBirney. U. S. Department of Agriculture, Circular No. 488; 10 cents.

Formulae for Completely and Specially Denatured Alcohol. Available in two forms: Printed in Federal Register, January 4, 1939; 10 cents; and as a separate, Appendix to Regulations No. 3, Bureau of Internal Revenue; 5 cents.

Alcohol Statistics. Three mimeographed Treasury Department releases are: Annual Report of Federal Alcohol Administrator for period December 15, 1937 to December 15, 1938; Statistics on Distilled Spirits and Rectified Spirits and Wines, Fiscal Year Ended June 30, 1938; and Statistics on Fermented Malt Liquors and Cereal Beverages, Fiscal Year June 30, 1938.

Changes in Import Duties Since the Passage of the Tariff Act of 1930. A new edition bringing together in one list all changes in import duties occasioned by various trade agreements. U. S. Tariff Commission, Miscellaneous Series, January 1, 1939; 45 cents.

Second Trade Agreement between United States and Canada. The Tariff Commission is issuing a series of four volumes giving digests of trade data regarding products on which concessions were granted by the United States. The first of these, Volume II, covers chemicals, earthenware, metals, and wood.

Phosphate Resources. Two documents are: Senate Document No. 21, 76th Congress, 1st Session. Report of Congressional committee to investigate the adequacy and use of the phosphate resources of the United States; 5 cents. Government Explores Public Phosphate Lands in Florida. Department of Interior mimeographed release showing results of Geological Survey investigations, November 16, 1938.

Federal Power Commission Laws and Hydroelectric Power Development Laws. Superintendent Document Room, House of Representatives; 15 cents.

Earnings and Hours in the Fireworks Industry, October 1937. Bureau of Labor Statistics, Serial No. R. 821.

Federal Specifications. Soap, Soft; (For) Automobile and General-Cleaning, P-S-612; 5 cents. Paint; Graphite, Outside, Ready-Mixed, Black, TT-P-27; 5 cents.

Census of Manufactures, 1937. Final preliminary statistics giving commodity breakdowns for certain industries are now available. A general summary by industries giving statistics for all industries is also available. Census Bureau; mimeographed.

Directory of U. S. Government Films. United States Film Service, National Emergency Council; mimeographed.

Research—A National Resource. Relation of the Federal Government to Research. National Resources Committee; 50 cents.

Summary of Legislation Relating to Water Resources, 75th Congress, 3d Session. National Resources Committee, Water Resources Committee, North Interior Bldg., Washington, D. C.; mimeographed. Available only from National Resources Committee.

Water Levels and Artesian Pressure in Observation Wells in the United States in 1937, by O. E. Meinzer and L. K. Wenzel. U. S. Geological Survey, Water-Supply Paper 840, $1.00. This document gives an up-to-date record of ground water levels which is valuable in appraising the availability of water in various parts of the United States.

Federal Trade Commission. Annual report for fiscal year ended June 30, 1938, giving a resume of recent investigations, orders, etc.; 15 cents.

Statistical Classification of Domestic Commodities Exported from the United States. Schedule B, Bureau of Foreign and Domestic Commerce, effective January 1, 1939; 25 cents.

Cupola Refractories. Simplified Practice Recommendation R154-38, Bureau of Standards; 10 cents.

List of Publications, Bureau of Mines, 1910-1937, and a separate Supplement covering period July 1, 1937 to June 30, 1938. Available only from Bureau of Mines, Washington, D. C.

Studies of Certain Properties of Oil Shale and Shale Oil, by Boyd Guthrie. Bureau of Mines, Bulletin 415; 25 cents.

Carbonizing Properties of West Virginia Coals and Blends of Coals from the Alma, Cedar Grove, Dorothy, Powellton A, Eagle, Pocahontas, and Beckley Beds, by A. C. Fieldner and others. Bureau of Mines, Bulletin 411; 30 cents.

Some Tests of Acid-Resistant Pipe, by R. D. Leitch. Bureau of Mines, Report of Investigations 3426; mimeographed.

Ore-Testing Studies, 1937-38. Progress report of the Metallurgical Division giving special methods of analysis and testing. Bureau of Mines, Report of Investigations 3425; mimeographed.

Primary Crushing. Summary of Field Tests, by Mark Sheppard. Bureau of Mines, Report of Investigations 3432; mimeographed.

Survey of Fuel Consumption at Refineries in 1937, by G. R. Hopkins. Bureau of Mines, Report of Investigations 3430; mimeographed.

An Explanation of Washability Curves for the Interpretation of Float-and-Sink Data on Coal, by G. D. Coe. Bureau of Mines, Information Circular 7045; mimeographed.

Safe Storage, Handling, and Use of Commercial Explosives, by D. Harrington. Bureau of Mines, Information Circular 7046; mimeographed.

Ichthyol—Its Source and Properties, by O. C. Blade. Bureau of Mines, Information Circular 7042; mimeographed.

Annual Report of the Nonmetals Division, Fiscal Year 1938, by Oliver C. Ralston and others. Contains numerous summaries giving resume of active research. Bureau of Mines, Report of Investigations 3427; mimeographed.

Preliminary annual figures of mineral production during 1938 are now being issued by the Bureau of Mines during February and March. Available from Bureau of Mines.

Income in the United States, 1929-37, by Robert R. Nathan. Bureau of Foreign and Domestic Commerce; 10 cents.

American Standard Safety Code for Protection of Heads, Eyes, and Respiratory Organs. Bureau of Standards, Handbook 24; 15 cents.

Safety Rules for the Operation of Electric Equipment and Lines. Bureau of Standards, Handbook 34; 10 cents.

Survey of Roofing Materials in the Southeastern States, by Hubert R. Snoke and Leo J. Waldron. Bureau of Standards, BMS Report 6; 15 cents.

Commercial Testing Laboratories Equipped for Chemical Analyses. Bureau of Standards, Letter Circular 534; mimeographed.

Fireproofing Fabrics, by Martin Leatherman. Department of Agriculture, Farmers' Bulletin 1786; 5 cents.

Selecting Fertilizers, by Albert R. Merz. Department of Agriculture, Circular 487; 5 cents.

Fumigation of Baled Cotton with Hydrocyanic Acid for the Pink Bollworm, by A. C. Johnson, George C. Becker, and Lon A. Hawkins. Department of Agriculture, Technical Bulletin 623; 10 cents.

Cooperative Tests of Housefly Sprays, 1935-36, by F. L. Campbell. Bureau of Entomology & Plant Quarantine, Department of Agriculture, E-436; processed document.

The Tung Tree, by H. L. Crane and Robert A. Young. Bureau of Plant Industry, Department of Agriculture; processed document.

Fuel Oils (Fourth Edition). Bureau of Standards, Commercial Standard CS12-38; 5 cents.

Analysis of Miscellaneous Chemical Imports Through New York in 1937. U. S. Tariff Commission mimeographed unnumbered release.

Nomographic Chart for Calculating Oleum Analyses and for Interconverting Physical Data of Oleum

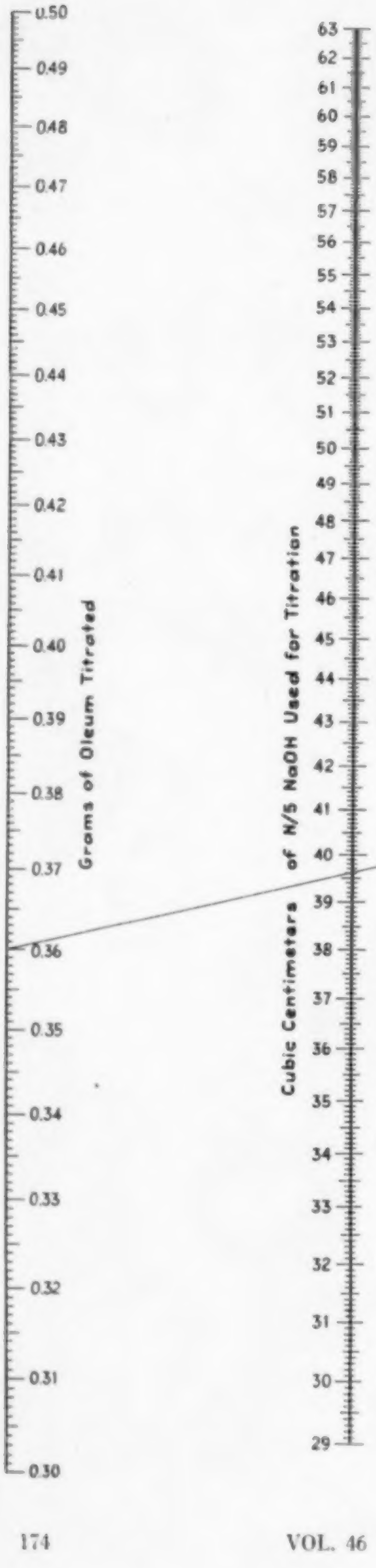
By ERNST BERL
Research Professor
Carnegie Institute of Technology
Pittsburgh, Pa.

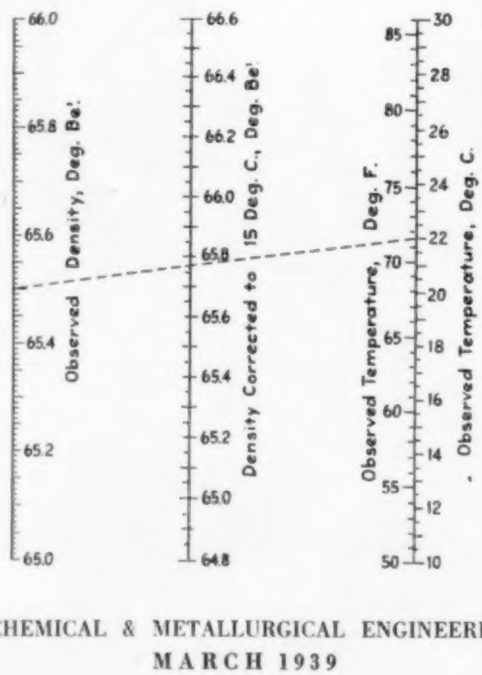
Chart II

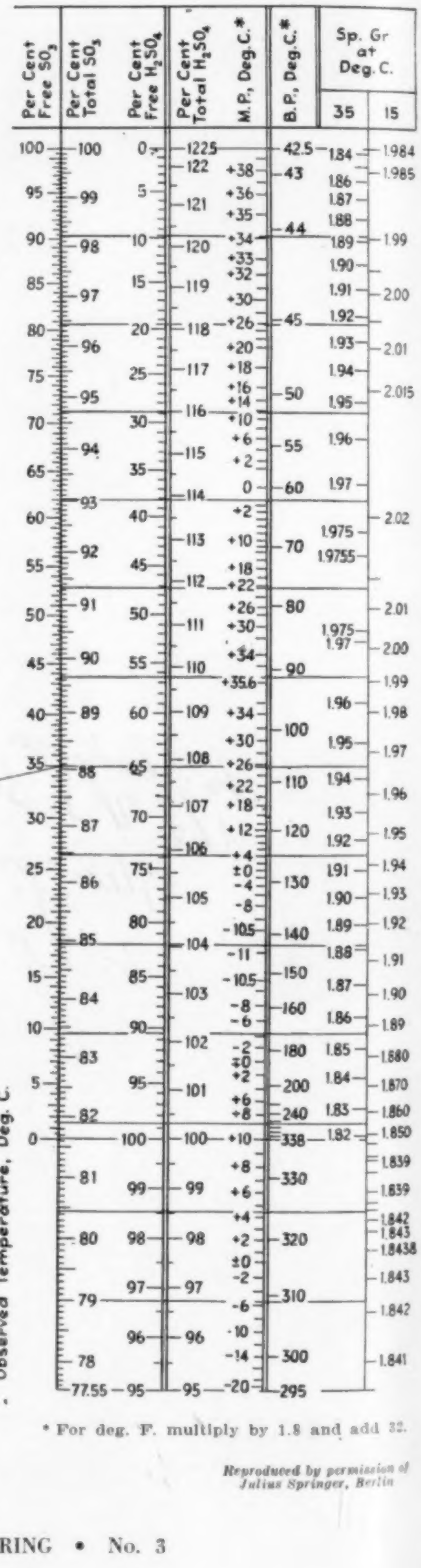
Example: A sample of oleum is titrated against N/5 NaOH, using 0.360 g. of oleum and requiring 39.61 cc. of NaOH solution. With a straight edge connect 0.360 on the left scale with 39.61 on the center scale and extend the line to 35.0 per cent free SO_3 on the first scale at the right. A horizontal line through this point shows that the sample contains 88.06 per cent total SO_3, 65.0 per cent free H_2SO_4, and 107.9 per cent total H_2SO_4. Its melting point is 25.8 deg. C. (78.4 deg. F.), its boiling point about 107 deg. C. (225 deg. F.) and its specific gravity at 15 deg. C. (59 deg. F.) about 1.967. The chart may similarly be used for sulphuric acid of strengths from 95 to 100 per cent.

The small nomograph below is useful for making temperature corrections of the Baumé of H_2SO_4 of 65-66 deg. For example, as shown by the dashed line, acid measured as 65.5 deg. Bé. at 22 deg. C. is of 65.77 deg. Bé. when corrected to 15 deg. C.

Note: These charts are presented second in a series translated from a more extended series published in 1930 by Julius Springer of Berlin, under the title of "Nomographic Charts for the Chemical Industry." In their original preparation Dr. Berl had the assistance of Drs. W. Herbert and W. Wahlig.







* For deg. F. multiply by 1.8 and add 32.

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Process Equipment NEWS

Machinery, Materials and Products

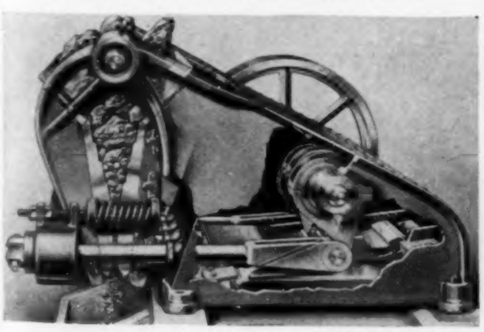
Car Loader

EXTREME MANEUVERABILITY is the outstanding characteristic of a new gas-powered tiering truck, known as the Clark Carloader, recently introduced by the Clark Tructractor Division of Clark Equipment Co., Battle Creek, Mich. Designed for loading and unloading freight cars and for handling cargo in and out of stowage space, the Carloader has a 38-in. overall width, a 38-in. wheelbase and a turning radius so small that the machine can turn around inside a boxcar without backing. It picks up the load, lifts it, tilts it back 10 deg. for safe carrying, carries it at speeds ranging from 1 to 7 m.p.h., elevates it, tilts it forward 2 deg. for easy tiering and returns for another load. Models are available with capacities of 2,000, 3,000 and 3,500 lb., tiering to 60 in. Also, three telescopic models are built in corresponding capacities, able to tier to a height of 108 in.

The new machine was developed by the company to take advantage of the method of purchasing in which the buyer specifies the most suitable size and weight of package for shipment, handling and storage. Using the Carloader, the buyer is able to take the package from the freight car, warehouse it and send it to production, all with the same piece of materials handling equipment. The Carloader can be provided either with standard lifting fingers, or with a special lift plate attachment for handling barrels, drums and heavy crates.

Car-loading tiering truck

Cut-away view of new balanced crusher

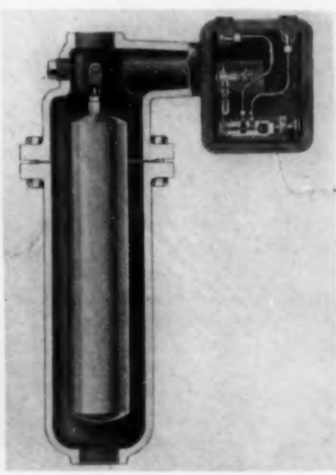


Balanced Crusher

A MACHINE claimed to employ a new crushing principle of opposed, balanced pendulum jaws, is the Kue-Ken crusher recently announced by the Straub Mfg. Co., 507 Chestnut St., Oakland, Calif. The new machine bears some resemblance to an ordinary jaw crusher, but differs considerably in the method of applying the crushing force. In the Blake type of crusher, for example, one jaw is fixed and the other is pivoted at the top. In the new machine, both jaws are movable, pivoted at the top and oscillated simultaneously and in opposite directions at the bottom. The effect of the opposed motion is to permit dynamic balancing and the substantial elimination of vibration. High speeds are possible and both power requirement and upkeep are said to be materially reduced. The use of long jaw plates permits combining primary and secondary crushing in the one machine and thus makes possible a large ratio of reduction in a single pass.

The manufacturers point to the fact that the design employs five times the usual leverage, thus requiring no flywheel. The drive mechanism is completely sealed against dust and provided with cascade lubrication. Massive foundations are not needed even at the usual speeds of 350-400 r.p.m. Sizes range from the No. 10 machine receiving a rock 10x5 in., to the No. 150 machine, capable of receiving rock 48x16 in. Larger machines are built to special order.

Throttling level control



Liquid Level Controller

TYPE 246 LevelTrol is the name of a new long-range liquid level controller recently announced by the Fisher Governor Co., Marshalltown, Ia. This instrument is of the remote type, designed to maintain sensitive throttling level control in towers, accumulators, reboilers and other equipment. The operating medium may be either air or non-corrosive gas.

The new control is said to operate equally well on liquids of any specific gravity, being particularly suited for high viscosity oils. The instruments employs a new princpile of operation, based on the weight measurement of buoyancy rather than a float riding on a moving level. An anchored cantilever spring supports the float which is specially weighted to sink in the liquid being handled. As the liquid rises, that displaced by the float creates a buoyancy which partially relieves the cantilever spring. This action is transmitted to a pilot valve which in turn changes the control pressure on the diaphragm valve. Level changes as small as 1/32 in. are stated to register a pressure change at the diaphragm.

Tank Linings

THREE new tank lining materials recently announced by the United States Stoneware Co., Akron, Ohio, include Tygon, a material entirely resistant to hot oxidizing agents; Ruplastoid, resistant to

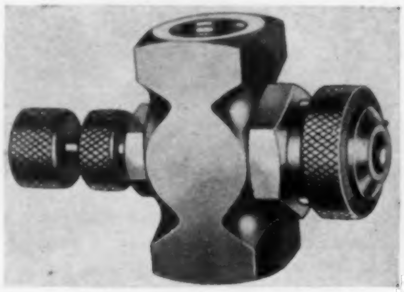
all acids except those that are highly oxidizing and solutions which contain solvents or hydrocarbons; and Rubber-X which is resistant to all plating and pickling solutions that can be handled in standard rubber linings.

Tygon was developed for lining steel, wood and concrete tanks, particularly for pickling such products as stainless steel. This product, a synthetic rubber said to be entirely immune to attack by nitric acid, is produced by calendering together a number of fabric sheets which have been impregnated with the material. The built-up sheets are applied to the wall of the container, and the joints welded together with strips of the same material. Customarily the Tygon lining is protected with acid-proof brick and cement from mechanical and thermal damage. The resulting tank is said to be completely resistant to all acids including hydrofluoric, as well as to alkalis, hydrocarbons and most solvents.

Ruplastoid linings are described as relatively inexpensive. They employ a thermoplastic material which is available in several grades for use up to 200 deg. F. Ruplastoid is supplied in bulk, sheet and paste form.

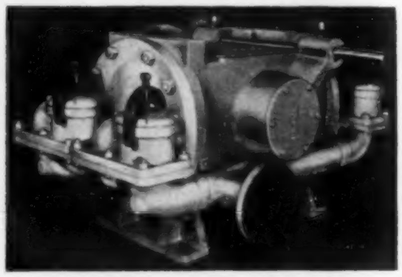
Rubber-X linings are applied by painting or spraying the material which is a self-curing latex emulsion. Several films are applied to build up the desired thickness. Protection of the coating with an acid-proof brick lining may be provided if desired.

Neoprene-coated protective clothing



Pneumatic atomizing nozzle

New air-cooled hoist



New bottom-connected diaphragm pump

Protective Clothing

A RECENT ANNOUNCEMENT from the Rubber Chemicals Division of E. I. duPont de Nemours & Co., Wilmington, Del., describes tests that have been conducted in a sulphuric acid plant on the use of neoprene-coated protective clothing in comparison with the rubber protective clothing that was previously used. This plant found that the rubber protective clothing, used to guard workmen against acid splashes and accidental leaks from pipes and valves, had to be replaced every four to six weeks. A workman's suit made from cloth coated with neoprene was still in active use after 5½ months service, at which time it was stolen so that its total life was never determined. The success of the first garment led to the adoption of safety hoods made from neoprene, constructed as shown in the illustration at the top of the page.

Spray Nozzles

SEVERAL new spray nozzles have recently been introduced by Spraying Systems Co., 4922 West Grand Ave., Chicago, Ill. The company's new pneumatic atomizing nozzle (illustrated herewith) is stated to give a spray of uniform distribution with complete atomization. Types available give an externally mixed round spray; an internally mixed round spray; and an internally mixed flat spray. Both compressed air and liquid connections are ¼ in. Recommended applications include humidifying and various spraying operations requiring complete atomization.

A new non-pneumatic atomizing spray nozzle giving a hollow cone spray, also made in the ¼-in. size, with or without strainer, is built in capacities from 1 to 14 g.p.h. at 40 lb. water pressure. A new wide-angle, "Parasol," non-clogging, hollow-cone spray is made in connection sizes ranging from ⅛ to ½ in., with capacities from 0.5 to 4.0 g.p.m. at 10 lb. pressure. The manufacturer recommends the use of this type wherever an exceptionally wide angle of spray is required.

Air-Cooled Hoist

BUILT IN CAPACITIES from ¼ to 6 tons, the new Cable King wirerope electric hoist, recently announced by Yale & Towne Mfg. Co., Philadelphia, Pa., is stated to be the only air-cooled hoist on the market. The air-cooling feature is provided for cooling the brakes and main gear assembly. Outside air is sucked into the motor brake housing and circulated under pressure over and around the portion containing the load brake and main gears. Both gears and brakes are totally inclosed to prevent the entry of dirt. Antifriction bearings are employed throughout. Control equipment may either be of the pendant chord or the push-button type. The load brake is of the Weston screw and disk type, self-actuating; and the motor brake of the external contracting drum type, actuated by a plunger type solenoid. All hoists are equipped with upper limit stops to prevent overtravel. A variety of models is obtainable in each capacity, with various lifts and lifting speeds. Both alternating- and direct-current motors are available.

Diaphragm Pump

FOR PUMPING metallic salts, slimes, slurries and sludges, particularly those containing a relatively high percentage of quick settling solids, T. Shriver & Co., Harrison, N. J., has designed a new diaphragm pump with intake and discharge manifolds at the bottom of the pump. The pump is of the duplex type, the material handled being kept from contact with the actuating mechanism by means of two rubber diaphragms. Only the liquid ends, valves, valve seats and manifolds need to be made of special material, resistant to the product being handled. The pump is designed for easy inspection and cleaning and is regularly made in capacities up to 100 g.p.m. at pressures to 100 lb. per sq.in. Special pumps for larger capacities and pressures to 250 lb. per sq.in., can be supplied.

Gas Detectors

THREE new gas-detecting instruments, a methane tester, a benzol indicator and a hydrocyanic acid gas detector have recently been announced by the Mine Safety Appliances Co., Braddock, Thomas and Meade Sts., Pittsburgh, Pa. The new methane tester is a pocket-size instrument weighing less than 3 lb., complete with dry cells. Its accuracy is stated to be comparable to that of an Orsat gas analysis apparatus. The new benzol indicator is a supersensitive in-

strument with a range from 0 to 1,000 parts per million of benzol in air. Concentrations can be read directly to within 20 parts per million. An absorption tube for benzol vapors is provided, making it possible to balance the electrical circuit in the presence of benzol vapors. The new HCN gas detector measures concentrations ranging from 0.005 to 0.10 per cent by volume and can be operated by any workman. The detector consists essentially of an aspirator bulb, a specially prepared detector tube and a scale graduated to read directly in percentage HCN. Air drawn through the detector tube where any HCN is present reacts with a chemical, turning it deep blue. The length of coloration along the tube is proportional to the gas concentration.

This company has also introduced two new instruments for dust sampling. One, the Midget Impinger, weighs less than 10 lb. for ready portability and is hand-operated. The other, an electrostatic dust and fume sampler weighs less than 25 lb. and is capable of sampling a volume of 3 cu.ft. of air per min., operating on 110 volt, 60 cycle, alternating current.

Compression-Screw Packer

AUTOMATIC PACKING of powdered solids is the function of a new electric compression-screw packer recently announced by Sprout, Waldron & Co., Muncy, Pa. With this packer, the operator's only duties are to place the empty container on the platform, push a starting button and remove the filled container. The machine will handle free-flowing powders or materials that have enough inherent flow to pass from the receiving hopper into the packing tube. Package sizes may range from a 50-lb. sack to a 400-lb. barrel. Depending on the size of the container, packing pressures as high as 800 lb. may be secured. Allowing time for the operator to put on an empty bag and take off the filled bag, the packer has a capacity of four bags per minute. The machine can be used either as a packer or as a filler. A simple handwheel adjustment permits altering the packing pressure, while setting the machine for minimum pressure serves to make it act as a filler, with just enough pressure to prevent hollow pockets at the bottom of the bag.

Change-Tank Mixer

RAPID and thorough mixing of all kinds of paints, enamels, varnishes and other semi-fluid substances is said to be possible with the new change-tank mixing head recently announced by the Abbé Engineering Co., 50 Church St., New York, N. Y. This new Abbé-Lenart mixer can be inserted in any type of container and is designed for quick change of batches without loss of time. The container is placed under the mixing head which is then lowered by means of a hand wheel. The mixing head is similar in principle to the standard Abbé-Lenart type, employing a rapidly rotating agitator disk below a stationary funnel, which creates a vortex above and below. The mixing head is balanced by a counterweight for easy raising and lowering. Four sizes are available, for containers ranging from 1 to 250 gal.

Improved Flow Instruments

SEVERAL improved rotameters have recently been put on the market by Fischer & Porter Co., 110 West Penn St., Germantown, Philadelphia, Pa. One of these is an instrument for measuring the flow of materials which would be solid at room temperature and hence must be maintained at an elevated temperature during the metering. The same construction is employed for materials which must be refrigerated during metering to prevent their flashing to vapor. The end fittings of this rotameter are equipped with jackets through which steam or cold brine can be circulated. The metering tube itself is encased in an outer glass tube and the intervening space evacuated to approximately one micron pressure, thus practically preventing heat flow either to or from the metering tube. An important advantage is that frosting of the glass is thus prevented.

Another new rotameter (illustrated herewith), which is intended for the handling of opaque liquids, consists of a standard rotameter body with an extension tube mounted above or below in which a piston attached to the end of an extension rod carried by the float slides in close contact with the tube wall. This extension tube, like the rotameter tube, is made of precision bore glass and the piston can be seen regardless of the opacity of the liquid. Holes in the piston prevent its acting as a dash pot.

The company has also made improvements in its remote reading and controlling rotameters. Smaller remote instruments employ electrical transmitter coils mounted directly around a standard rotameter tube thus positively preventing any possibility of leakage from the tube into the metering coils. Larger capacity meters use transmitter coils suspended beneath the lower metering tube fitting. The construction has been redesigned so that a tell-tale stuffing box is located between the meter body and the transmitter assembly, preventing any leakage from running down into the coils. For purposes of flow control, a null balance measuring instrument is employed, coupled with an air-operated control system, a method said to be much simpler than the electric controllers formerly employed.

Still another development is in the improvement of the company's tubular case rotameter which has been simplified and reduced in overall length to permit pricing on a lower basis.

New Products

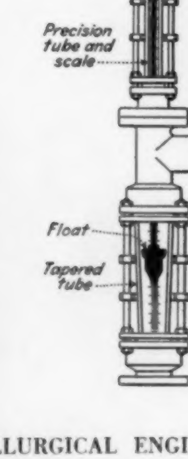
EXCEPTIONAL WET STRENGTH, combined with exceptional filtering ability and resistance to alkalis and acids, is claimed for the new Shark Skin filter paper, developed for industrial use by Carl Schleicher & Schüll Co., 167 East 33d St., New York, N. Y. Compared with an ordinary grade of filter paper, the new material showed 30 to 90 times the wet strength under hydraulic pressure tests. Two sheets of the material are stated to retain cold precipitated barium sulphate particles. Most precipitates, according to the manufacturer, are retained by one sheet of the material. Tests of resistance to various materials showed no effect by concentrated nitric acid after seven days, nor by 25 per cent sulphuric acid after five days. The material retained its strength after seven weeks in 20 per cent caustic soda.

A NEW soap antioxidant, known as Sopanox, has been announced by the

New compression screw packer

Abbé-Lenart change-tank mixer

Rotameter for opaque liquids



Rubber Service Laboratories Division of Monsanto Chemical Co., 1012 Second National Bldg., Akron, Ohio. This amino compound is said to be effective in minute quantities in restraining the oxidation of soap and the resulting rancidity, discoloration and other adverse qualities which must be avoided in producing a product of the first grade. The material imparts no odor or color to soap and does not affect the performance of the soap in any way.

Commercial availability of a new ester, dibutyl sebacate, has been announced by the Resinous Products & Chemical Co., 222 West Washington Square, Philadelphia, Pa. This material is useful as a chemical plasticizer for nitrocellulose and other plastic compounds, having properties similar to other commonly used plasticizers such as dibutyl phthalate and tricresyl phosphate. Several advantages in comparison with these materials, however, are claimed. The new material is said to be particularly effective for plasticizing vinyl and acrylic type resins.

Power-Type Pressure Gage

Bailey Meter Co., Cleveland, Ohio, has announced a power type pressure gage similar to a dead-weight gage, suitable for measurement of extremely high pressures and accurate to 1/10 per cent of the reading. The pressures to be measured are applied to a small pressure piston which supports a pilot valve and a table loaded with removable weights. As the table is supported on a ball bearing, the continuous rotation of the shaft (to prevent sticking) need not be communicated to the table. The same motor which rotates the shaft operates an oil pump to provide hydraulic pressure for operation of a power piston. Part of the weight of the weight table is supported by displacement of mercury in a mercury cup, the position of which is fixed by the power piston.

When the applied pressure increases or decreases, the pressure piston, pilot valve and weight table rise or fall. In so doing oil under pressure passes through the pilot valve to the upper or lower side of the power piston, thus changing its position and lowering or raising the mercury chamber. This action alters the buoyant force of the mercury and changes the effective weight on the piston so as to oppose and balance the pressure change. Thus, for each pressure, there is a definite corresponding position of the power piston which is indicated on a scale and may be transmitted to a remote indicator by means of a Selsyn motor.

Carbonaceous Zeolite

For the production of water of zero hardness, reduced total dissolved solids, and any desired degree of alkalinity, the Permutit Co., 330 West 42d St., New York, N. Y., has developed Zeo-Karb, a new carbonaceous, practically non-siliceous, zeolite material which can be regenerated either by acid or by salt.

When regenerated with acid, the Zeo-Karb reacts with the dissolved constituents in water so as to exchange hydrogen ion for the sodium, calcium and magnesium ions in the water, converting all the carbonates and bicarbonates to carbonic acid which is later removed by aeration. An effluent of low total solids content is consequently produced. Operating in this fashion, the material is referred to as Hydrogen Zeo-Karb (Zeo-Karb H). When the material is regenerated with common salt it operates similarly to other previously known zeolites and is referred to as Sodium Zeo-Karb (Zeo-Karb Na). Zeo-Karb Na is recommended for use in softening raw waters that are low in silica, particularly for use in treating boiler feed water for high pressure boilers. Zeo-Karb H is employed in boiler feed water conditioning for high pressure boilers, in ice manufacturing, in preparation of certain beverages, in brewing, leather, paper manufacture, certain classes of dyeing and for other special purposes.

The most common method of employing the new zeolite is to pass part of the water through Zeo-Karb H and another part through Zeo-Karb Na, mixing the two effluents so as to produce the desired degree of acidity or alkalinity. In this method a rubber-lined shell containing Zeo-Karb, provided with an acid-regenerative system, operates parallel with a bitumastic-lined shell, equipped for salt regeneration. The raw influent is split in a definite proportion between these two units and the two flows are mixed as they enter a slat-packed degassifier for the removal of carbon dioxide by blowing with air. Smaller installations, or those operating on water relatively low in chloride and sulphate, sometimes employ only a single Zeo-Karb unit, regenerated with acid, the effluent from which is neutralized with an alkali.

The accompanying chart illustrates the comparative effect upon hardness, total dissolved solids and alkalinity, of various types of treatment.

Power type pressure gage for 12,000 lb. service

Explosion-Proof Motor

Fairbanks-Morse & Co., 600 South Michigan Ave., Chicago, Ill., has announced a new line of explosion-proof, ball-bearing motors, which has been approved by Underwriters' Laboratories for Class 1 group D hazardous locations, as in plants producing or employing gasoline, acetone, alcohols, volatile oils, etc.

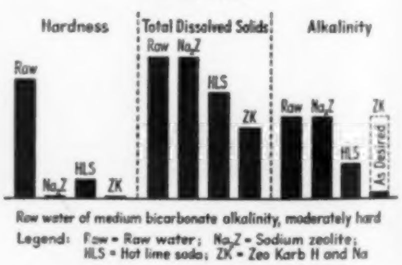
The new motors are built in NEMA frames and hence can be applied as easily as standard open motors. Double-end ventilation, assuring positive cooling from both ends of the motor and eliminating hot spots, is a feature of the larger motors of the line. The smaller motors, that is those employing frames 204 and smaller, are of the non-ventilated type.

Equipment Briefs

A new line of positive rotary pumps, especially designed for sanitary characteristics and ease of cleaning, has been put on the market by the Blackmer Pump Co., Grand Rapids, Mich. The pumps are provided with a clamp-type head which can quickly be removed, after which the impeller and buckets can be slid out so that the entire pump interior is accessible for sterilization. Except for the sanitary features, the principle of the pump is similar to that of other Blackmer bucket-type rotary pumps. Two sizes are available, 50 and 100 g.p.m.

Protection against organic vapors, acid and ammonia gases is afforded by a new rubber twin-filter-type respirator developed by H. S. Cover, South Bend, Ind. The new Dupor No. 10 respirator is equipped with two cartridges of special charcoal for organic vapors, soda lime

Comparison of results obtained with Zeo-Karb, sodium zeolite and hot lime-soda treatment



Double-end-ventilated explosion-proof motor

for acid gases and copper sulphate for ammonia gases. The cartridges are readily removable and replaceable by new ones whenever desired. Special care has been taken to insure positive elimination of breathed air.

STEPHENS-ADAMSON MFG. CO., Aurora, Ill., manufacturers of the J. F. S. line of variable speed reducers, has added a line of constant speed reducers under the name of Saco. The motor is supported on top of the reducer, driving it by means of a multiple V-belt. High efficiency of 89-93 per cent is claimed. Precision cut helical steel gears operating in an oil bath and the use of anti-friction bearings are features of the design.

PREVIOUSLY a manufacturer of 10 and 12 in. recorders, the C. J. Tagliabue Mfg. Co., Brooklyn, N. Y., has recently added a line of 9-in. recorders. These recorders are available both for temperature and pressure, and have all the features of the larger instruments, but occupy only half the space.

ESPECIALLY designed for the protection of outdoor electrical equipment, the new Fire-Fog system recently announced by Walter Kidde & Co., 140 Cedar St., New York, N. Y., employs a special nozzle so designed that a central solid jet of water meets a twisting, converging current of water, to produce a uniformly solid cone of finely divided spray at low nozzle pressure. Burning liquid such as a transformer oil is cooled below its flashpoint, blanketed with a continuous spray of water, and steam is formed in sufficient quantities to dilute the flammable vapors and exclude the air needed for combustion.

FOR TESTING seams in tanks and pipe lines, the American Pipe & Steel Corp., Alhambra, Calif., has inaugurated a new seam-testing service, making use of a patented device for applying vacuum to the area under test. The device consists of an air-tight box equipped with a vacuum gage, the top of the box covered with glass, and the bottom provided with soft rubber strips for sealing to the surface under test. In use, a section of the seam is covered with a thick solution of soap suds and the device is placed over the covered area and vacuum created by means of a suction pump. Imperfections in the seam permit the inflow of air which is detected through the glass top of the seam tester by bubbles.

A NEW WASHING FIXTURE, semi-circular in shape and 36 in. in diameter, with a capacity of three persons, has been announced by the Bradley Washfountain Co., Milwaukee, Wis. Designed for use in small washrooms, the fixture is available in enameled iron or stainless steel, either hand or foot-controlled, and in standard or deluxe models.

MANUFACTURERS' LATEST PUBLICATIONS

Agitators. Eclipse Airbrush Co., Pneumix Division, 390 Park Ave., Newark, N. J.—6-page illustrated folder on performance of this company's air-motored agitators in laboratories and industrial plants.

Boilers. Edge Moor Iron Works, 30 Rockefeller Plaza, New York City—Bulletin 105—4 pages with engineering data describing this company's low-head boilers for 100 to 600 hp. capacity, at 125 to 900 lb. pressure.

Boilers. Henry Vogt Machine Co., Louisville, Ky.—20-page book on this company's Class ML-L low-head-type bent-tube boilers, with drawings illustrating a considerable variety of actual installations, complete with dimensions.

Castings. Smith Steel Foundry Co., 1320 South First St., Milwaukee, Wis.—4-page folder illustrating a considerable number of types of stainless steel castings produced by this company and listing six commonly used Smith alloys.

Chemicals. Shell Chemical Co., San Francisco, Calif.—Second of a series of books on properties of chemicals manufactured by this company, dealing with specifications, properties and uses of a variety of solvents.

Construction Material. Pomona Pump Co., Pomona, Calif.—Information Bulletin 4—8-page booklet describing Pomoloy C-2, a 40,000-lb high-strength plain cast iron used for the various cast iron parts of this company's pumps. Said to be superior in corrosion-resistance, density, tensile strength and ductility to ordinary cast iron.

Couplings. Pittsburgh Equitable Meter Co., 400 North Lexington St., Pittsburgh, Pa. — Bulletin No. M-700 — 12 pages with engineering data describing in detail the Raybould coupling for pipe lines, now being distributed by this company.

Disintegration. Abbe Engineering Co., 50 Church St., New York City—Bulletin 45—4 pages describing this company's rotary knife cutters for the disintegration of such products as chemicals, roots, drugs, fibers, leather, paper, rags and rubber.

Electrical Equipment. Diehl Mfg. Co., Elizabethport, N. J.—Price List and Catalog No. 39—25 pages on this company's electric motors, generators and ventilating equipment, listing a wide variety of types of motors. Includes several types of exhaust fans, some with explosion-proof motors.

Electrical Equipment. Durakool, Inc., Elkhart, Ind.—Bulletin 503—8 pages describing in detail this company's metal-encased mercury switches, with auxiliary leaflet giving technical specifications, operation characteristics and application data.

Equipment. Stearns Magnetic Mfg. Co., Milwaukee, Wis.—Bulletin 650—Describes this company's Style DM magnetic disk brake.

Equipment. Struthers-Wells-Titusville Corp., Titusville, Pa.—18-page booklet describing this company's equipment for process industries use, covering such types as pressure vessels, dryers, mixers, heat exchangers, condensers, evaporators and miscellaneous fabricated equipment.

Gaskets. Goetze Gasket & Packing Co., New Brunswick, N. J.—Bulletin 51A—Leaflet giving sizes, dimensions and prices of this company's gaskets for ring-joint flanges.

Inert Gases. Roots-Connersville Blower Corp., Connersville, Ind.—Bulletin 100-B13—8-page bulletin describing this company's inert gas generators, showing types, construction and operation information, with additional information on applications.

Instruments. Mason-Neilan Regulator Co., 1190 Adams St., Boston, Mass.—Bulletin 416—12 pages on this company's direct-connected liquid level controllers and accessories such as balanced valves and gage glasses.

Instruments. Wheelco Instruments Co., 1929 South Halsted St., Chicago, Ill.—Bulletin 4201—Leaflet describing this company's industrial indicating control thermometer for temperatures to 1,000 deg. F., with brief information on the "no-contact" electronic principle employed.

Materials Handling. Link-Belt Co., 307 North Michigan Ave., Chicago, Ill.—Book 1630—20-page picture-book on mechanical handling with overhead conveyors, showing application of such equipment in a wide variety of industrial uses.

Materials Handling. Mathews Conveyor Co., P.O. Drawer 191, Elwood City, Pa.—32-page revised edition of "Natural Laws Applied to Production," a handsomely bound and printed book dealing with the principle of continuous flow applied to modern industrial organization. Discusses in particular the "laws of materials handling," fundamental types of conveyors, and the types suitable for various typical requirements.

Metal Hose. Chicago Metal Hose Corp., Maywood, Ill.—Catalog G-14—38 pages completely describing this company's flexible metal hose, its types and applications; includes engineering data.

Porcelain. Lapp Insulator Co., Le Roy, N. Y.—8-page book describing this company's new line of chemical porcelains, including laboratory and plant equipment, pipe, filters, etc.

Power Transmission. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—Book B2159—36 pages on this company's geared drives for industrial use, showing a large number of application views of a variety of types of geared transmission equipment produced by this company.

Pumps. Pomona Pump Co., Pomona, Calif.—Bulletin 28—12-page book describing this company's Niagara low-lift pumps for large water flows at low power consumption.

Resistoflex. Resistoflex Corp., 370 Lexington Ave., New York City—8-page folder describing Resistoflex PVA synthetic resin tubing and the physical and chemical properties of this hydrocarbon-resisting material.

Tank Supports. Templeton, Kenly & Co., 1020 South Central Ave., Chicago, Ill.—Bulletin 835—12 pages of engineering data on this company's Simplex adjustable supporting jacks and drop-forged and cast saddles for tanks, autoclaves, stills and other equipment, used for simplifying supports and foundations.

Tubing. Babcock & Wilcox Tube Co., Beaver Falls, Pa.—Technical bulletin 6-C—Revision and enlargement of previous editions, giving digest of properties of carbon and alloy steel tubing for high-temperature, high-pressure service, with information on effects of alloying elements, creep testing, thermal expansion, thermal conductivity, etc.

Washroom Equipment. Bradley Washfountain Co., Milwaukee, Wis.—Form R219—4-page leaflet describing this company's semi-circular washfountains in 54 and 36 in. diameters, for up to six users.

Water Analysis. W. H. & L. D. Betz, 235 West Wyoming Ave., Philadelphia, Pa.—18-page manual on water analysis with information on procedure and calculation of results, as well as on chemicals required and apparatus for tests.

Chemical Engineering NEWS

Fifteen Symposia Will Feature A.C.S. Baltimore Meeting

Fifteen symposia reporting advances in scientific research and in the application of chemistry to industry, medicine, agriculture, and food, engineering, and public health will be outstanding events of the ninety-seventh meeting of the American Chemical Society, which will be held in Baltimore, April 3-7. Dr. J. C. W. Frazer, Baker professor of chemistry in the Johns Hopkins University, has been appointed honorary chairman of the meeting. Dr. John C. Krantz, Jr., professor of pharmacology in the Medical School of the University of Maryland, has been named general chairman.

Seventeen of the eighteen professional divisions of the Society will hold sessions. The Division of Chemical Education plans four sessions—one a joint symposium with the Division of Physical and Inorganic Chemistry on "Theories and Teaching of Acids and Bases"; another devoted to a group of papers on chemical education in high schools; a third, for student papers; and, finally, a session for miscellaneous papers within the field of the division.

The convention will formally open on Monday, April 3, with a meeting of the Society's council, followed at 2 p.m. by a public meeting in the Polytechnic Institute Auditorium. Many group events, including visits to the industries, educational institutions and points of historic interest in Maryland, will supplement the convention program. Representatives of the Society's eighty-five sections will convene. Reports will be presented by the administrative officers of the Society.

T.A.P.P.I. Re-elects Officers at Annual Meeting

The twenty-fourth annual meeting of the Technical Association of the Pulp and Paper Industry was held in New York City, Feb. 20-24. Symposiums were held on the following subjects: industrial engineering, forming and finishing, alkaline pulping, acid pulping, materials of construction, coating, and other phases of the pulp and paper manufacture.

Frederick C. Clark and R. G. Macdonald were re-elected president and secretary respectively. W. H. Swanson, staff superintendent of sulphite, Kimberly-Clark Corp., Kimberly, Wis., was elected vice-president of the Association. Elected to the executive committee for three-year terms were: V. P. Edwards of the International Paper Co.; R. C. Griffin of Arthur D. Little, Inc.; H. H. Harrison of the Crystal Tissue Co. and F. D. Libby of the Kalamazoo Vegetable Parchment Co.

J. N. Stephenson, editor of the *Canadian Pulp and Paper Magazine*, was presented with the Association's medal for 1939 in recognition of his outstanding contribution to the technical advancement of the industry. Mr. Stephenson is editor of the five volumes dealing with the manufacture of pulp and paper, sponsored by the technical associations of the United States and Canada. One of the features of the meeting was the annual luncheon which was addressed by L. A. Hawkins, executive engineer of the General Electric Co. whose subject was "Invention, the Mother of Necessity."

The 1939 fall meeting of the association will be held at Syracuse, N. Y., Sept. 12-14. Headquarters will be at the Hotel Syracuse.

Symposia Arranged for Meeting Of Electrochemists

The spring meeting of The Electrochemical Society will be held at Columbus, Ohio, April 26-29, with headquarters at the Deshler-Wallick Hotel. Prof. James R. Withrow is chairman of the local committee in charge. The sessions will center largely around two important symposia on Organic Electrochemistry and Refractories for the Electrochemist.

Prior to the technical sessions, the board of directors will meet. Robert L. Baldwin, president of the Society, will conduct the annual business meeting.

On the morning of April 27. L. J. Trostel of Baltimore will preside at the opening scientific-technical session which will treat of "Refractories in the Electrochemical Industries." At luncheon Prof. George Glocker of the University of Minnesota will speak on "Theoretical Electrochemistry of Gases." The following morning division chairmen will be in charge of sessions on "Electrodeposition" and "The Electric Furnace." The dinner-dance will be held in the evening and Mr. Baldwin will deliver the presidential address on "Contributions of the Electric Furnace to Modern Warfare."

Trips of inspection will include visits to important industrial plants in Columbus and Newark with an optional all-day trip on April 27, to Dayton for inspection of plants in that city.

National Safety Congress Will Meet in Atlantic City

The 1939 National Safety Congress and Exposition—the world's biggest annual safety event—will be held in Atlantic City, N. J., Oct. 16-20. The Safety Congress is the annual meeting of members and committeemen of the Council and brings together approximately 10,000 safety leaders from all parts of the world. This year there will be 130 sessions and 600 speakers at the Congress, touching on every phase of safety—industrial, traffic, home, school and public. The sponsoring committee which will handle local arrangements for the Congress is headed by Gov. Harry E. Moore of New Jersey as honorary chairman and General Edward C. Rose, president of the Public Service Electric & Gas Co. of Trenton, as general chairman.

Research Laboratories Form American Council

Leading research and testing laboratories of the country have mutually bound themselves together in the American Council of Commercial Laboratories to maintain testing, research, inspection and the laboratory art as a whole upon a high plane and to conduct their operations in such a manner as to insure competency and reliability in whatever they may undertake.

Member laboratories are located from coast to coast with branch laboratories and inspection stations in every important city and industrial center in the country. Membership in the Council is open to commercial laboratories which qualify to the strict requirements and pledge to abide by the high code of ethics set up in the Council by-laws.

Western Resources Studied as Aid to Chemical Development

Prospects for the development of electrothermal, electrolytic and chemical industries in the 11 far Western states form one part of a comprehensive and exhaustive two-volume report on the industrial resources of that region recently printed by the Industrial West, Inc., a non-profit cooperative organization established to compile data for use in exhibits at the Golden Gate International Exposition at San Francisco. The report covers all phases of the industrial resources and markets of the Pacific Basin. It was prepared by a staff of experts under the direction of George W. Malone, former state engineer of Nevada, at a cost of $135,000, with the cooperation of many state and federal agencies and bureaus.

BUSINESS is being wooed by the New Deal. This time the effort is serious and sincere. This is more than one of those "breathing spells."

The reason for all this is not difficult to identify. New Dealers are afraid of the 1940 ballot if good business does not develop soon. The temper of Congress compels the reformers to be patient, if not conservative. Industry temporarily benefits.

Chemical engineering enterprise can count upon this general movement to postpone some of the otherwise aggressive reform efforts of Washington. But this is a postponement and not a fundamental change in attitude of either the President or of his most-trusted advisers. They still want concentration of authority in Washington. They still intend to concentrate this Washington authority in the White House, when they get a chance. The results of 1940 elections will determine whether someone of this temperament or someone of more conservative purpose takes charge after the need for the present lull in reform has passed.

Plans for Congress

The President is intimating that he would like Congress to wind up its affairs rather soon and go home before mid-Summer. This probably means that the Administration has given up hope of getting out of the present Congress any more laws that the Executive wants. It probably means also that the President and his close advisers are very much afraid of Congress on tax revision, amendment of N.L.R.B. law, and other efforts restricting New Deal agencies. The President would much rather wait for reorganization of the Departments and like legislation than to risk the undoing of some of the reforms achieved with difficulty in earlier years.

But Congress seldom quits when the optimists forecast that it will. Something always happens. This year revision of tax laws is likely to be the cause of protracted legislative effort. This means that there will be time for enactment of a number of other bills such as those proposing limitation of stream pollution, and perhaps some revisions of the patent law. Modifications outlined in *Chem. and Met.* last month are still expected to be materially advanced. But in early March it remains anybody's guess whether any patent legislation can finally be enacted this year. Certainly no anti-monopoly features of patent law will have attention.

Food and Drug Regulation

The new Food and Drug Law has set up what officials term "a ten-ring circus". They are not even content with the conventional seven-ring of Barnam & Bailey fame. Every feature of the regulation of foods and chemicals used in foods, drugs, or cosmetics is now subject to hearing, argument, proposed regulation,

NEWS FROM WASHINGTON

Washington News Bureau
McGraw-Hill Publishing Co.
Paul Wooton, Chief

and bitter controversy. F. & D. Administration officials are making haste slowly, giving full opportunity for industry critics to influence the form of rules before even tentative adoption. They hope to make any regulations stick for a good long time when they are finally put into force.

Tax Law Changes

Congress' economy plans have the President and Secretary Morgenthau on the run. The Administration does not like this. Certainly Harry Hopkins who started the movement had no intention of letting it run away as it has. The story generally believed around Washington goes about like this:

Hopkins wrote a speech for delivery in Des Moines. He sent it to the White House just before the President left for naval maneuvers and fishing. The President liked the idea of assuring business against further tax increases. He made a brief announcement to reporters before going to sea. Morgenthau grabbed the ball on what he thought was an official pass to him. He assured the public that the Treasury would cooperate. Then Senator Harrison and Representative Doughton, in command of appropriation committees in the two Houses, took charge. They announced that they would cut all taxes, not merely refrain from adding new ones. Hopkins speech was warmed-over mashed potatoes by the time he got to deliver it, very unpalatable to the Secretary of Commerce.

What Congress will do about cutting present Revenue laws remains problematic. But certainly there will be either —(1) a big cut in appropriations, or (2) a bigger than \$3 billion deficit, or (3) no tax relief for business, perhaps even slight tax increases. At this time no one can safely forecast the temper of Congress. And Congress, not the White House, will decide on this fundamental legislative question.

News "Fines"

New TVA Battle—Fertilizer interests are vigorously opposing the plan for a new commercial-size blast furnace for manufacture of phosphoric acid under TVA operation. The House defeated a proposed \$430,000 appropriation for this purpose, but the Senate appropriations committee favors it. Naturally all fertilizer manufacturers are worried because of over-generous production capacity.

Strategic Materials—Those backing appropriations for buying stocks of strategic and critical materials are much encouraged by late February developments in Washington. It looks as though preparedness planning might include the building up of reserves of these commodities. Process industries will of course be affected and may participate in some of the planning.

Fertilizer "Trust"—The Justice Department has launched a new inquiry of the fertilizer industry to break up monopolistic practices based on "uniformity of prices". The political benefits to Congressmen expected may be greater than the benefits to farmers and consumers who are the nominal gainers if F.T.C. makes any progress in showing why farm prices of fertilizers are too high. The industry is worried because of the public relations consequence, but does not appear disturbed by any charges of collusion or improper combinations or price agreements.

Plastic Airplanes—Radical new aircraft designs are being seriously considered in the course of the air preparedness planning. One scheme proposes that the whole of the aircraft body be made of plastic material. Any other new ideas, no matter how radical, will get a chance to demonstrate their worth during the expansion of research and development work which will attend new spending for 6000 planes for the Army. Materials makers, as well as aircraft builders, are taking notice.

Secondary Metals—Plans of the Bureau of Mines for more thorough investigation of the secondary metals problems have been consummated by the formal establishment at Pittsburgh of a new economic statistical unit. Recycling of metals and other minerals will be more completely studied than heretofore under the direction of James S. Earle, newly named chief of this unit.

Vegetable Oil Tariffs—The Senate Finance Committee has been urged by southern interests to favor the proposal to increase import duties on vegetable oils from 3¢ to 5¢ a lb. It was pointed out that large supplies of imported oils depressed values for domestic oils such as cottonseed, peanut, soybean, and corn. Soap and linoleum interests not only opposed imposition of higher duties but favored elimination of present ones.

NEW CHEMICAL PRODUCTS EXHIBITED AT ANNUAL BRITISH INDUSTRIES FAIR

From Our London Correspondent

The annual British Industries Fair opened at London and Birmingham on Feb. 20. The number of exhibitors of chemical interest was smaller than for the past few years, but some products of new interest were shown. One exhibitor made a special display of products for stabilizing fire extinguishing materials. A new development in water treatment consists in the use of very small quantities of sodium metaphosphate to prevent the deposition of calcium carbonate caused by heating waters containing temporary hardness, or by the addition of small amounts of soda ash or caustic soda to such waters. Catechol and aceto acetanilide of British manufacture, now produced in sufficient quantities and at a suitable price to compete with the imported materials, also were shown. Several new accelerators for the rubber industry were exhibited by Monsanto Chemicals, Ltd. A pure ceric ammonium sulphate which is readily soluble in cold dilute sulphuric acid, a fluorescent cadmium tungstate, edestine, hormones and special analytical reagents and indicators (3:6 dihydroxy-phthalimide, 3:6 dihydroxy-phthalonitrile and β-methyl-umbelliferone as examples of the indicators) were among other products shown.

As a result of the government's land fertility scheme, demand for basic slag has been greatly stimulated, and supplies of home-produced material have been inadequate to meet demands of farmers. Nearly 410,000 tons of basic slag were applied for during the 1937-38 fertilizer season, so far as applications September 1937 to May 1938 were concerned. This quantity was estimated to be 70 per cent more than the demand during the previous fertilizer season. Home supplies are dependent upon the production of certain kinds of steel, which has recently shown a notable increase and the future appears to be well assured for the adherents of basic slag.

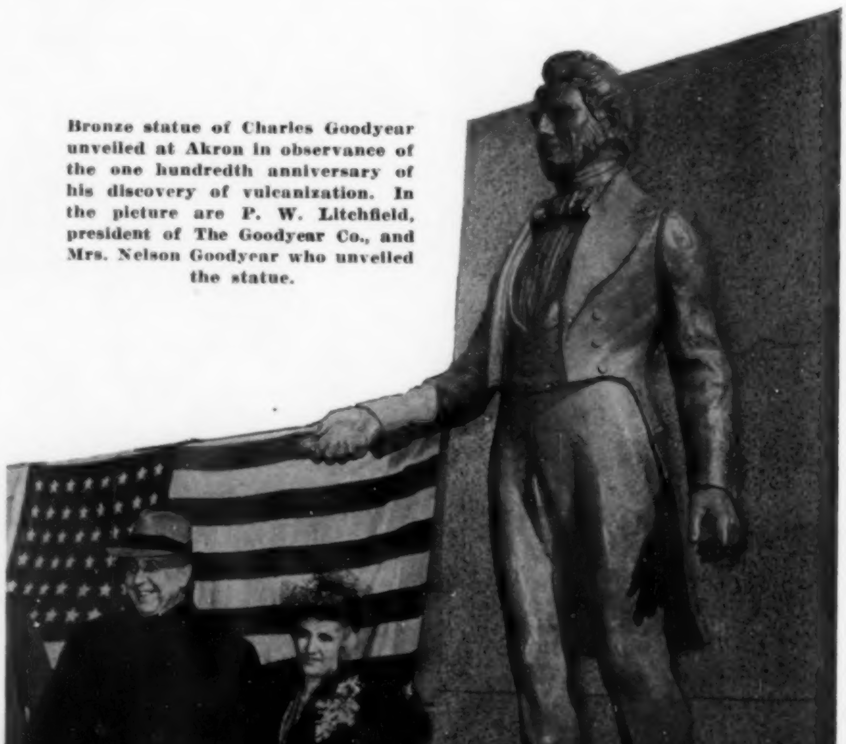
The annual report of the British Sulphate of Ammonia Federation shows that home consumption of sulphate of ammonia for use as a fertilizer remains at about the same level as for the previous year, although there is a slight increase of 0.6 per cent. taking the whole of the British Isles. For England and Wales alone, the increased consumption amounted to 3.8 per cent; a decrease of 9.4 per cent in Ireland and an increase of only 1.4 per cent in Scotland affected the total home consumption. Total exports show an increase of 18 per cent.

Continued activity in the development of trading estates to relieve unemployment appears to be furthering the establishment of industries making use of chemicals; several small chemical works dealing mainly with pharmaceutical products also have been newly established. Proposals for new works for the manufacture of carbide are still under consideration, the establishment of large works at a site in North Wales now being greatly in favor.

Trade figures for 1938 show a fall in both imports and exports of chemicals, drugs, dyes and colors; the decrease in imports is £643,000 but the decrease in exports is £2,604,000. Heavy chemical imports have been almost negligible compared with exports, but the latter have fallen in respect to bleaching powder, soda ash, salt and caustic soda. There has also been a considerable drop in exports of finished dyestuffs. The outstanding increases among the imports are in potassium chloride and sulphate, sodium nitrate and quinine.

Following the trade agreement between the United Kingdom and the United States, comment is made that although a few reductions have been made on imports of chemicals into the United States—in particular, tar products—the level of duties has been so high that little extra business is likely to result as a consequence of these reductions. The reductions given to Canada by the United States, however, may actually benefit the United Kingdom.

Translucent magnesia, a newly introduced product of the Washington Chemical Co., is rapidly finding use in the manufacture of translucent rubber, and orders of increasing size are being received from different parts of the world as well as from English rubber manufacturers. Special grades of magnesia are produced by this company, which is a subsidiary of Turner and Newall, Ltd. During the past year one special grade has been introduced for the insulation of an electric cable which is in production in England. In other directions magnesium products are also coming into the limelight; the development of magnesium trisilicate as a pharmaceutical, for instance, shows steady progress and has been the subject of clinical research.



Bronze statue of Charles Goodyear unveiled at Akron in observance of the one hundredth anniversary of his discovery of vulcanization. In the picture are P. W. Litchfield, president of The Goodyear Co., and Mrs. Nelson Goodyear who unveiled the statue.

GERMANY USES NEW PLASTICS AND ALLOYS IN AUTOMOBILE AND AIRPLANE INDUSTRIES

From Our German Correspondent

PRODUCTION in the German chemical and allied industries has generally reached new highs despite a drop in exports in some fields. Balance sheets for 1937-8 operations of leading companies show continued increases also in employment and consumption of energy.

Germany's steel production in 1938 was around 23 million tons, this rise having necessitated construction of a larger number of blast furnaces and sintering plants, especially for treatment of lower grade ores. During the first nine months of 1938, domestic ore production rose to 8.2 million tons, which is one-third higher than a year before. The utilization of domestic ores, especially those of the Salzgitter area in central Germany, has brought with it a number of technical problems which were discussed before the Verein Deutscher Eisenhuettenleute at their recent annual meeting in Duesseldorf. The Salzgitter, like the Dogger ores, do not have a lower iron content than the Minette ores of Lorraine, but the difference is found in the composition of accompanying materials such as silicates which cut down economy in smelting. It has been possible, however, to enrich the air blast mixture with the addition of 26 per cent oxygen so that the Gutehoffnungs-Huette in Oberhausen succeeded in cutting down coke requirements from 1530 kg. to 1304 kg. per ton of raw iron, thereby increasing blast furnace efficiency by 48 per cent.

To save iron and steel and cut down the amount of steel used in building without sacrificing strength, new forms are constantly being devised. Lighter constructions using welded plate forms, for instance, instead of cast iron and steel parts has led to savings of as much as 50 per cent in weight in machine building, to 40 per cent in the under framework of passenger railway cars, up to 50 per cent in the construction of hangars, halls, etc., up to 30 per cent in street cars, and up to 30 per cent in the construction of boilers and apparatus. In shipbuilding industries, more and more ships are being constructed in Germany without the use of rivets. Considerable steel is saved through welding; on the recently completed ship "Wilhelm Gustloff," whose hull was entirely welded instead of riveted, it was possible to effect a saving of 1300 tons of iron and steel, which represented 14 per cent of the total weight of the ship.

New plastics also are used increasingly in the shipbuilding industry in place of metals for fixtures, window frames, etc. Because of corrosion resistance to salt water and sea air, plastics have numerous advantages. They are also used as wall coverings in place of panel woods, thereby reducing the fire hazard and making considerable painting and varnishing unnecessary. Because of lightness as compared with metals, the use of plastics has effected considerable weight saving in ship construction.

In the recently completed new "Graf Zeppelin," plastics found wide use; 450 kgs. of "mipolam" and "astrolan" were included in the construction. The polyvinyl chloride thermoplastic "mipolam" (see *Chem. & Met.*, Nov. 1936) has been used for the floor covering of the cabins as well as for walls in the wash rooms. Tables, chairs, wash basins, etc., were also made of this light, practically unbreakable and non-flammable material. Dynamit A.G. producers of "mipolam," are developing plastics for large pressed pieces with a high rigidity to be used in building auto bodies.

For building the new low-priced auto in the Fallersleben Volkswagen Fabrik, one of the largest presses in Germany, weighing 360,000 kg., has been assembled. The head piece, weighing 95,000 kg., was cast by the Dortmund Hoerder Huettenverein.

Licensing of automobiles has been placed on a new basis, according to engine types, under a reçent decree. All new automobiles since Oct. 1, in order to obtain licenses, must be suitable for operation with a motor fuel with an octane rating of 74. "New Motors and Motor Fuels" was the theme of the autumn meeting of the V.D.I. in Augsburg. In connection with the latest diesel developments it was announced that coal-tar oil, which heretofore could be used only for slow running diesel motors, can now be used in faster diesel trucks through addition of the highly combustible fuel "Kogasin 2," which is attained through the Fischer-Tropsch gasoline synthesis. It is claimed that through this mixture, high quality diesel fuels can be produced which will be suitable for sensitive machines and which are superior to petroleum fuels in combustibility. At the Augsburg meeting it was also reported that the coal dust engine, after several years of experimenting, has reached the stage where it may soon be produced commercially.

For the protection of the gigantic Leuna Werke in central Germany, one of the leading centers of synthetic gasoline and ammonia production, new and anti-aircraft measures have been introduced. In addition to the anti-aircraft artillery and pursuit planes, balloon nets similar to those developed in London were used during air raid maneuvers in December, which centered around the protection of the Leuna Werke and other important central German industrial plants. According to official announcement, at least, it was declared that the "attack" had been repulsed and that the balloon blockade along with other anti-aircraft measures could successfully protect these vital industries against air raids.

Through regeneration of old materials, it was possible to fulfill 12 per cent of Germany's raw material requirements during the past year. Old paper collected amounted to over 1 million metric tons, which represented a saving of the equivalent of 1 million cubic meters of best pulp wood; 150 communities in Germany, through sorting their garbage, from September, 1937 to July, 1938, reclaimed 55,000 tons of scrap iron; 1300 tons of pure tin were reclaimed from old tin cans, and the total value of old materials regained was estimated at 550 million RM.

A new potential source of cellulose in Germany has been reported by Dr. Bleyschlag of the Institute for Petroleum and Mineral Refining Technique, Berlin. Laboratory experiments have shown that the content in lignite of fossile cellulose (1 to 40 per cent), after proper mechanical and chemical preparation, including treatment with alkalis, can be used for cellulose production. The fibrous material which now occurs as a nuisance and has to be removed in the bricketting of lignite, would yield, with a recovery of 15 per cent one million tons of cellulose annually, and it is claimed that the process is technically feasible.

E. M. Allen Appointed Sponsor For World's Fair Ticket Sale

Edwin M. Allen, president, of Mathieson Alkali Works, Inc., is urging the chemical industry to cooperate in the advance ticket sale now being sponsored by the New York World's Fair. This campaign will make it possible for every person in Greater New York to purchase "bargain tickets" to the Fair at substantial reductions from the regular admissions. This sale is a special privilege restricted to the people living in the metropolitan area. Mr. Allen is acting as sponsor for the advance sale of these cut-rate tickets to the chemical industry. Since the sale of these tickets is so strictly a local affair, the plan of distribution has taken on the form of a community activity. Sixty prominent leaders —including Mr. Allen—have been appointed as sponsors of the sale for each of the several divisions in the industrial, mercantile, utility, professional and educational fields in the city. Thomas H. McInnerney, president of National Dairy Products Corp., will act as general sponsor for this special sale.

PERSONALITIES


Davis Studios
A. S. Finlayson

✦ M. G. Milliken, general manager, Cellulose Products Department, Hercules Powder Co., sailed March 4 for a combined pleasure and business trip to the European countries.

✦ Norton Gerber is now a research engineer with Servicised Products Corp., Chicago.

✦ J. J. B. Fulenwider has been appointed assistant general manager of the Cellulose Products Department of the Hercules Powder Co. Mr. Fulenwider, who was educated at the United States Naval Academy and served as ensign and lieutenant in the engineering department of the Navy, became associated with the Hercules organization in 1926.

✦ James C. Coull of the chemical engineering staff at Cooper Union, has been appointed head of the department at the University of Pittsburgh. Professor Coull was born at Aberdeen, Scotland. He received graduate instruction at Columbia University and the Massachusetts Institute of Technology, and was employed by the Tide Water Oil Co. before going to Cooper Union.

✦ Z. G. Deutsch has announced his entry into the field of consulting work in New York City. He will specialize in the preparation of reports and the specification of equipment for the heavy chemical industry. Mr. Deutsch was associated first with the Solvay Process Co. and later with the Mathieson Alkali Works.

✦ Charles D. Luke, who joined the faculty of the College of Applied Science, Syracuse University, in September, 1937, has been appointed acting head of the department of chemical engineering, succeeding the late Dr. Lloyd Logan who passed away in December. After completing his formal education at the State University of Iowa and at the Massachusetts Institute of Technology, he served with the process engineering department of the Standard Oil Co. of Louisiana and later on the staff of Luis de Flores, consulting engineer of New York.

✦ G. E. Hillbert has been appointed scientific advisor, with headquarters at Washington, D. C., in the general organization of the Regional Research Laboratories which are being established by the Department of Agriculture. Dr. Hilbert was formerly in charge of the section on organic investigations, Fertilizer Research Division, Bureau of Chemistry and Soils.

✦ W. B. Van Arsdel, formerly head of the Development and Engineering Section of the U. S. Regional Soybean Industrial Products Laboratory at Urbana, Ill., has been transferred to Washington, D. C., and appointed technologic advisor in the general organization of the Regional Research Laboratories which are being established by the Department of Agriculture.

✦ Donald B. Mason has been appointed technical director of the Freeport Sulphur Co. by Langbourne M. Williams, Jr., president. In his new position Mr. Mason is responsible for coordinating the various research activities of the company and interpreting with management technical developments in the chemical and other industries served by the company.


Blank-Stoller, Inc.
Frederick C. Clark


Greystone Studios, Inc.
J. J. B. Fulenwider

✦ Henry M. Walton has recently joined the research staff of the Continental Carbon Co., New York, N. Y., where he will engage in research work on carbon black. Dr. Walton, who received his doctor of laws degree at the University of Frankfort am Main in 1933, and a Ph.D. in chemistry at the University of Chicago in 1938 following special study abroad, brings unusually thorough training to this type of work.

✦ J. Howard Flint has recently become associated, as a patent lawyer, with the firm of Mason, Fenwicke & Lawrence, Washington, D. C. He had been practicing for several years in New York and Washington, specializing in the chemical field.

✦ Arthur J. Williamson has been added to the technical staff of Summerill Tubing Co., Bridgeport, Pa., as metallurgical engineer in charge of research and development.

✦ R. W. Higbie, new member of the chemical engineering staff of the University of North Dakota, Grand Forks, has taken over the teaching duties formerly held by Dr. O. T. Zimmerman, who accepted a position with the University of New Hampshire.

✦ Guy Harcourt, manager of the New York office of the Buffalo Foundry and Machine Co., has been made vice-president of the company. He will be located at the headquarters of the organization in Buffalo, N. Y., after May 1.

✦ H. H. Tucker, of the New Jersey Agricultural Experiment Station, has been appointed to the position of agronomist and manager of regional office to be opened in Columbus, Ohio. His work will embrace promotion and research in connection with the use of byproduct ammonia as fertilizer. This work will be under the direction of the Barrett Co.

✦ R. E. Christie has become assistant to the president of the Crucible Steel Co. of America.

James Coull

Guy Harcourt

Z. G. Deutsch

✦ A. S. Finlayson will be placed in charge of the new ethyl cellulose plant of Hercules Powder Co. at Hopewell, Va., when production starts in April. William Koch will look after the research and development.

✦ Irving Hochstadter of the chemical engineering firm of Stillman & Van Siclen has been elected director to represent the New York State Society of Professional Engineers in the affairs of the national organization.

✦ William D. Barry of the Mallinckrodt Chemical Works was elected chairman of the Drug, Chemical and Allied Trades Section of the New York Board of Trade and Ralph E. Dorland of the Dow Chemical Co. was elected vice chairman at a special meeting of its executive committee.

✦ Lewis Roberts and Wilder Gutterson have formed the firm of Engineering Products Service, in New York.

✦ L. A. Delaney has succeeded Charles E. Neudorfer as mill superintendent of William B. Scaife & Sons Co., Oakmont, Pa. The latter has been appointed to the newly created position of chief engineer.

✦ F. A. Abbiati, formerly with the Merrimac Chemical Division of Monsanto Chemical Co., has been made sales manager of all the company's sheet plastics. He has already taken up his new duties at Springfield, Mass.

✦ George W. Dolan, assistant to the president of the Mathieson Alkali Works, has been elected a member of the board of directors.

✦ Clarence E. Sims of the staff of the Battelle Memorial Institute, Columbus, Ohio, is visiting England for the purpose of studying developments in the iron and steel industry.

✦ Frederick C. Clark, tissue division, Pond's Extract Co., Seymour, Conn., has been reelected president of TAPPI.

✦ James Martin has been promoted from superintendent of the Hewitt Rubber Corp.'s Buffalo plant to the position of assistant factory manager. His new duties will include the coordination of production, mechanical and technical problems in all factory divisions.

✦ George A. Hobach, formerly with the Akron Paint and Varnish Co., and more recently employed in the laboratory of the Sherwin-Williams Co. in Cleveland, has joined the sales Staff of Wishnick-Tumpeer, Inc.

OBITUARY

✦ John Becker, one of the pioneers in the citrus byproduct industry died on Dec. 21, 1938. Mr. Becker was born on Mar. 27, 1885, in Peoria, Ill. He went to San Diego, Calif., 20 years later and immediately went to work on citrus waste products.

✦ James M. Gager, president of the Gager Lime Manufacturing Co., died at his home on January 30, following a heart attack. He had been active in the National Lime Association, which he has served as a director, and at the time of his death was a member of the executive committee.

✦ John A. Eades, secretary of the Read Machinery Co., died February 5, at the York Hospital, where he has been a patient since January 27. He was 43 years of age.

✦ Edmund C. Shorey, retired senior biochemist of the Bureau of Plant Industry, died January 30 at Emergency Hospital, Washington, D. C.

✦ William M. Perley, 62, a chemical engineer formerly associated with the Avery Chemical Co., Lowell, Mass., and a graduate of the Massachusetts Institute of Technology in 1898, died at his home in Medford, Mass., on February 4.

✦ George W. Goudy, general representative, foreign manager and director of the Philadelphia Quartz Co., died Feb. 7, 1939, in his sixty-ninth year, at his home in Highland, Ulster County, New York.

✦ Willard D. Biglow, director of research for the National Canners Association, died March 6 after several months illness at the age of 72.

CALENDAR

MARCH 29-31 National Farm Chemurgic Council, annual conference, Jackson, Miss.
APRIL 3-7, American Chemical Society, spring meeting, Baltimore, Md.
APRIL 16-21, American Ceramic Society, Hotel Stevens, Chicago, Ill.
APRIL 26-29, Electrochemical Society, spring meeting, Deshler-Wallick Hotel, Columbus, Ohio.
MAY 15-17, American Institute of Chemical Engineers, Akron, Ohio.
JUNE 18-22, American Electroplaters' Society, international convention, Asbury Park, N. J.
SEPT. 12-14, Technical Association of the Pulp & Paper Industry, fall meeting, Hotel Syracuse, Syracuse, N. Y.
DEC. 4-9, Chemical Exposition, Grand Central Palace, New York City.

Chemical ECONOMICS and MARKETS

CONSUMING TRADES CUT DOWN RAW MATERIAL REQUIREMENTS IN FEBRUARY

THE fairly even rate of manufacturing operations in the chemical-consuming industries which was maintained in January failed to hold up in February and while seasonal influences worked in both directions, the net change resulted in a drop in the relative rate which, in terms of actual raw-material consumption, was accentuated by curtailment in the number of working days. As March advanced, activities in general showed a tendency to rise and there was a renewal of optimistic forecasts for spring trading.

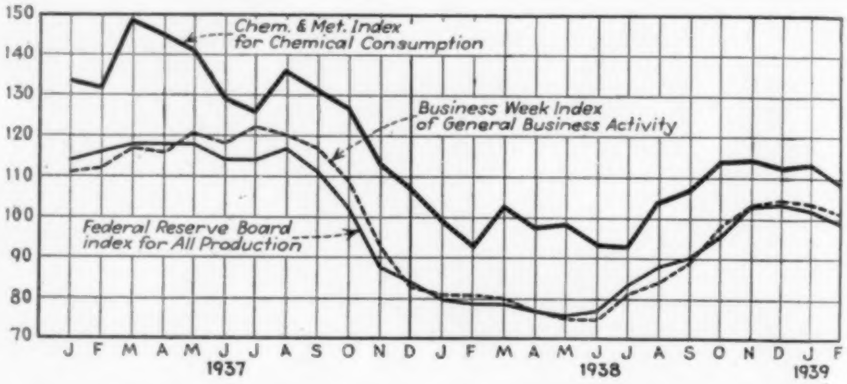
Chem. & Met.'s weighted index for chemical consumption stands at 114.03 for January as compared with a final revision of 113.71 for last December. Preliminary figures for February operations indicate that the index dropped below 110. This drop in part is due to the shorter month as the index is designed to show variations in actual consumption of chemicals with no adjustment for seasonal influences.

Chem. & Met. Index for Consumption of Chemicals

	December (Revised)	January
Fertilizer	27.33	26.10
Pulp and paper	14.52	14.00
Glass	10.39	10.46
Petroleum refining	12.84	13.10
Paint and varnish	6.91	7.80
Iron and steel	7.09	6.93
Rayon	8.41	8.63
Textiles	7.28	7.52
Coal products	6.85	6.83
Leather, glue and gelatine	3.72	4.09
Explosives	4.15	4.27
Rubber	2.56	2.56
Plastics	1.66	1.74
	113.71	114.03

Different divisions of the same industry have not moved in a uniform way. As a case in point flat glass production in January fell a little under the totals for December although the container division, which carries a higher weighting, registered a gain over the December figures.

There was practically no change, from a chemical-consuming standpoint, in the position of the rubber industry from November through January as variations in the amount of crude rubber consumed were offset by operations in rubber reclaiming. Rayon manufacture has been going along at a steady pace on a plane much higher than was the case in the early months of last year and enlarged staple production makes the comparison even more favorable than the figures for yarn would indicate.



Oil refineries maintained a high rate of daily operation during January but runs to stills were reduced in February until the last week, when a sharp rise was registered. The outlook for oil refining is somewhat mixed as steps may be taken to control production to prevent heavier accumulations of refined products.

Plastics may be cited as another example of an industry which is moving in an irregular manner. Enlarged production is reported for some types whereas the latest available figures show that cellulose acetate plastics have lost ground with changes in safety glass manufacture undoubtedly the chief contributory factor.

In the steel industry, prospects for a larger use of acid have been heightened by reports that the output of tin plate will take on more importance in the near future. This production in 1938 was at an unusually low level.

The Federal Reserve Board reports that since the end of last year, the volume of industrial production has shown less than seasonal rise and the adjusted index for February was about 99 per cent of the 1923-25 average compared with 104 for January. In the non-durable goods industries as a group activity is nearer the level of 1937 than are the durable goods industries. The *Business Week* index for general business was 104 for January and 101 for February.

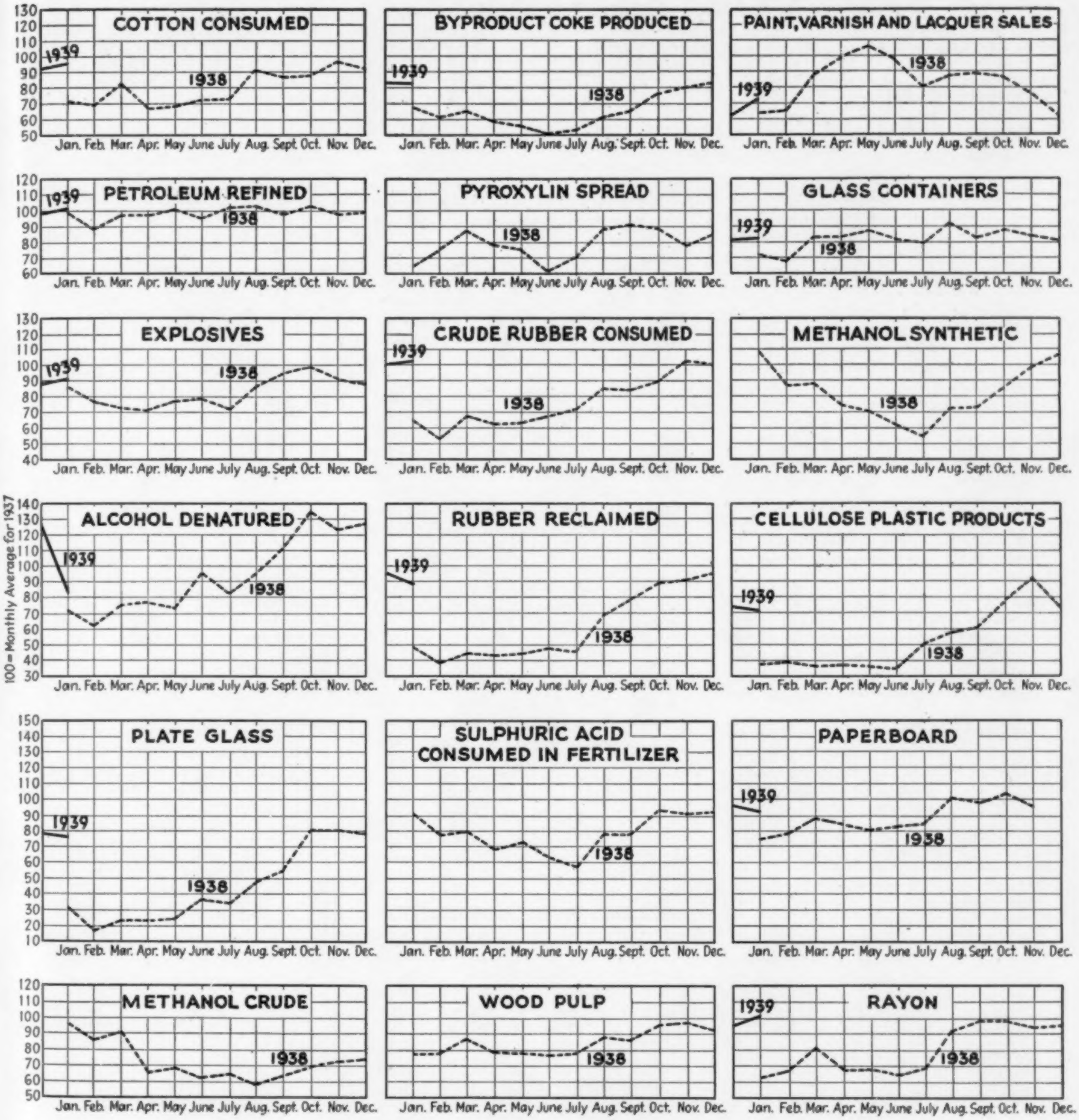
Production of synthetic methanol in January fell below the large total turned out in January 1938 but amounted to 2,462,884 gal. Production of crude methanol in January was above that for the corresponding month of last year with a total of 351,814 gal.

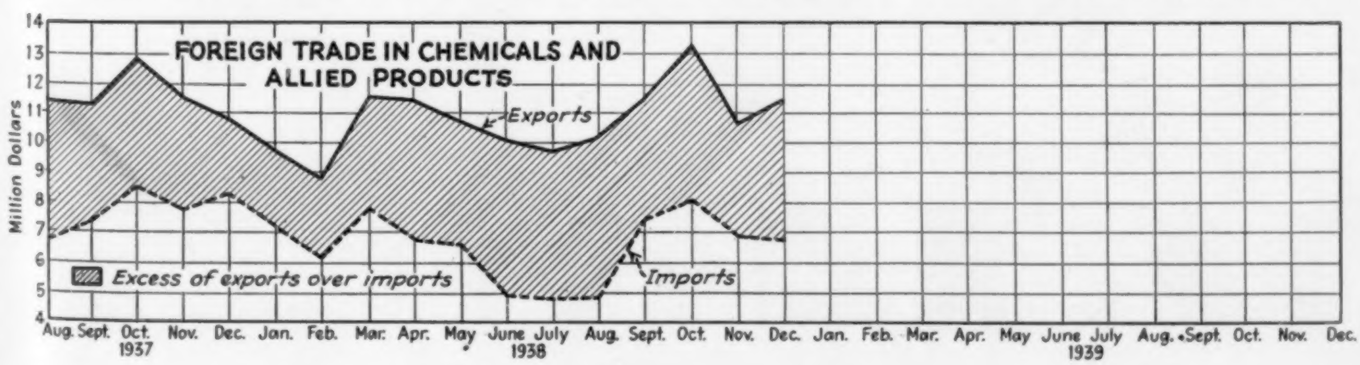
Production and Consumption Data for Chemical-Consuming Industries

Production	Jan. 1939	Jan. 1938	Dec. 1938	Per cent of gain Jan. 1939 over Jan. 1938	Per cent of gain Jan. 1939 over Dec. 1938
Alcohol, ethyl, 1000 pr. gal	17,067	15,607	16,772	9.4	1.8
Alcohol denatured, 1000 wi. gal	6,828	5,883	5,500	16.1	24.1
Ammonia, liquor, 1000 lb	4,264	3,655	4,363	16.7	2.3*
Ammonium sulphate, 1000 lb	91,513	75,469	91,674	21.3	....
Automobiles, No.	339,152	209,528	388,346	61.9	12.7*
Benzol, 1000 gal	7,783	6,155	7,802	26.4	....
Byproduct coke, 1000 tons	3,367	2,763	3,363	21.8	....
Glass containers, 1000 gr	3,589	3,125	3,515	14.8	2.1
Glass plate, 1000 sq. ft	12,209	5,119	12,691	138.5	3.9*
Glass, window, 1000 boxes	943	706	1,003	33.6	6.0*
Cellulose acetate plastics, 1000 lb	896	345	1,112	42.9	19.4*
Nitrocellulose plastics, 1000 lb	923	646	789	42.9	17.0
Rubber reclaimed, tons	13,763	7,467	14,712	84.3	6.5*
Consumption					
Cotton, bales	591,991	433,258	565,307	36.6	4.7
Silk, bales	40,816	30,715	35,204	32.9	15.9
Wool, scoured, 1000 lb	35,725	16,381	39,189	118.1	8.8*
Explosives, 1000 lb	29,257	27,754	28,415	5.4	3.0
Rubber, crude, tons	46,234	29,429	45,315	57.1	2.0

* Per cent of decrease.

Production and Consumption Trends





CONTRACT HOLDERS ORDER OUT CHEMICALS IN LARGER VOLUME FOR MARCH DELIVERY

SHIPPING instructions for chemicals are reported to have shown improvement since the first of the month with the majority of consuming industries showing more interest in deliveries. The movement of dyestuffs, in particular, has held up well since the first of the year with the textile, leather, and rubber trades taking considerably more than in the comparable period of last year. Building operations, actual and prospective, have presented one of the most favorable aspects of the market in recent months and account for the larger distribution of the various chemicals which enter directly or indirectly into construction work.

Chlorine has attracted wide interest in recent weeks because of the competitive situation which developed and which culminated in a lowering of tank car prices. In 1937, demand for chlorine exceeded the rated capacity of the country under the greatly enlarged call for supplies from the chemical, pulp, and water purification industries. To meet this contingency, production was pushed to beyond rated capacity proportions and steps were taken to add to the current installations. As a result, productive capacity has been greatly increased and consuming requirements throughout 1938 and the present year to date have fallen considerably below the 1937 levels. With the surplus output seeking a market outlet, competitive selling has become a factor with the usual effect on values. The lower price for chlorine reacts unfavorably upon electrolytic caustic soda since a relatively higher share of production costs must be borne by the latter whenever the revenue from chlorine sales declines.

Mixed amyl chloride was revised in price in the latter part of last month with tank-car lots now available at 4.65¢ per lb.; carlots in drums at 5.65¢ per lb. and less carlots at 6.65¢ per lb. All these quotations are on basis of f.o.b. producing point. Spirits of turpentine was higher at primary points and there was some evidence that prices for some of the other solvents had reached bottom and that further fluctuations probably would be on the up side.

The downward trend for vegetable oils and animal fats likewise has been checked and the weighted index number for the month registered a marked advance. Lard, which has been competing more actively in the edible field, has sold more freely in the export market and, with a greatly improved statistical position, has joined the rising price movement. This has reacted favorably on the market for cottonseed oil which in turn influenced the other vegetable oils. Linseed oil has been finding a better outlet and prospects favor a good spring season. This has tended to steady values and further strength has been given to the market by the fact that returns from the sale of cake are not up to expectations either in the way of unit prices or of volume of sales.

The position of vegetable oils is rendered more complex by the different proposals which have been presented to Congress. These range from proposed increase in import duties and higher excise taxes to removal of duty on oilseeds and placing the burden entirely on processing taxes. Hearings shortly will be held with a view toward clarifying action on the different proposals.

The monopoly investigation as directed toward the fertilizer industry has brought a reply from Chilean nitrate interests who denied the charge made by the Department of Justice that American consumers during the war were forced to pay three and four times the normal price for supplies of nitrate of soda. The denial of this statement points out that the price for Chilean nitrate in 1913 was $49.38 per ton which had risen to $93.94 per ton in 1918 with an average price for that six year period of $65.62 per ton or an advance of 33 per cent from the 1913 level. It was further pointed out that the rise in price was due largely to the extraordinary rise in ocean freights and in war insurance rates.

Interest in agricultural chemicals has been more apparent and producers of different lines have announced that current prices have been extended to cover deliveries over the coming season. Copper sulphate has been meeting with inquiries for export with no change in quotations during the last month.

Foreign producers of quicksilver have been moving prices up and, with the probable early settlement of the control of Spanish mines, it is expected that a working agreement similar to that in existence prior to the outbreak of the Spanish war will be arranged by Spanish and Italian producers. In the meantime, mercurials, Venetian red, and other products into which quicksilver enters as a necessary raw material, have been affected by the higher prices which have existed for the metal.

With the growth of consuming industries in South America, Mexico, and other countries and with the development of rayon production in Europe and the Far East, caustic soda has held a prominent place in export trade. For years Japan was the largest single buyer which gives additional prominence to the efforts which are being made to make Japan self-sufficient in this regard. In 1933 Japanese caustic consumption was estimated at approximately 118,000 metric tons. Surveys recently made by the two Japanese soda industrial associations indicate that demand in Japan in 1939 will be 460,000 metric tons. Production of caustic soda in Japan in 1933 was 110,953 metric tons. Based on the rate of operations up to September, the 1938 output would approximate 450,000 metric tons and imports were negligible, amounting to less than 500 metric tons. The further removal of Japan as an importer of caustic is seen in the report that the Japan Soda Co. is organizing a subsidiary to build an electrolytic plant in Formosa with an annual capacity of 25,000 metric tons. Demand for soda ash in Japan during the current year is estimated at 275,000 metric tons and the 1938 production is estimated at about 260,000 metric tons.

Consumption of commercial fertilizers in Germany during the last crop year exceeded the volume record established in 1936-37 by 14 per cent, according to a report from the American Consulate General, Frankfort-on-Main. Owing to drastic price reductions enforced by the Government, however, expenditures by farmers increased only 4 per cent to a total of 739,000,000 marks.

CHEM. & MET.

Weighted Index of

CHEMICAL PRICES

Base=100 for 1937

This month	**97.95**
Last month	98.27
March, 1938	100.43
March, 1937	99.68

The most important change in prices for chemicals was the reduction in the sales schedule for liquid chlorine. Most of the other heavy chemicals hold a steady price position. Spirits of turpentine was higher and the dropping price trend for solvents seems to have ceased.

CHEM. & MET.

Weighted Index of Prices for

OILS AND FATS

Base=100 for 1937

This month	**70.83**
Last month	67.71
March, 1938	80.31
March, 1937	114.72

Domestic vegetable oils closed at higher levels. This included crude cottonseed, soybean, peanut, and corn oils. Tallow and other animal fats were firm at the end of the period with advances in prospect. The weighted index number moved up appreciably.

Current PRICES

INDUSTRIAL CHEMICALS

	Current Price	Last Month	Last Year
Acetone, drums, lb	$0.05¾–$0.06½	$0.05¾–$0.06½	$0.05¾–$0.06½
Acid, acetic, 28%, bbl., cwt	2.23 – 2.48	2.23 – 2.48	2.23 – 2.48
Glacial 99%, drums	8.43 – 8.68	8.43 – 8.68	8.43 – 8.68
U. S. P. reagent	10.25 –10.50	10.25 –10.50	10.25 –10.50
Boric, bbl., ton	106.00–111.00	106.00–111.00	105.00–115.00
Citric, kegs, lb	.22½– .25	.22½– .25	.24 – .27
Formic, bbl., ton	.10½– .11	.10½– .11	.10½– .11
Gallic, tech., bbl., lb	.70 – .75	.70 – .75	.75 – .78
Hydrofluoric 30% carb., lb	.07 – .07½	.07 – .07½	.07 – .07½
Lactic, 44%, tech., light, bbl., lb	.06¼– .06¾	.06¼– .06¾	.6¼ – .6¾
Muriatic, 18°, tanks, cwt	1.05 –......	1.05 –......	1.05 –......
Nitric, 36°, carboys, lb	.05 – .05½	.05 – .05½	.05 – .05½
Oleum, tanks, wks., ton	18.50 –20.00	18.50 –......	18.50 –20.00
Oxalic, crystals, bbl., lb	.10¾– .12	.10¾– .12	.10¾– .12
Phosphoric, tech., c'bys., lb	.07½– .08½	.07½– .08½	.09 – .10
Sulphuric, 60° tanks, ton	13.00 –......	13.00 –......	13.00 –......
Sulphuric, 66°, tanks, ton	16.50 –......	16.50 –......	16.50 –......
Tannic, tech., bbl., lb	.40 – .45	.40 – .45	.40 – .45
Tartaric, powd., bbl., lb	.27½–......	.27½–......	.24½–......
Tungstic, bbl., lb	2.35 –......	2.35 –......	2.75 –......
Alcohol, Amyl	....–......	....–......	....–......
From Pentane, tanks, lb	.101–......	.101–......	.123–......
Alcohol, Butyl, tanks, lb	.08 –......	.08 –......	.08½–......
Alcohol, Ethyl, 190 p'f., bbl., gal	4.54 –......	4.54 –......	4.14 –......
Denatured, 190 proof			
No. 1 special, dr., gal. wks	.28 –......	.28 –......	.34 –......
Alum, ammonia, lump, bbl., lb	.03½– .04	.03½– .04	.03 – .04
Potash, lump, bbl., lb	.03¾– .04	.03¾– .04	.03¼– .04
Aluminum sulphate, com. bags, cwt	1.15 – 1.40	1.15 – 1.40	1.35 – 1.50
Iron free, bg., cwt	1.30 – 1.55	1.30 – 1.55	2.00 – 2.25
Aqua ammonia, 26°, drums, lb	.02 – .03	.02 – .03	.02½– .03
tanks, lb	.02 – .02¾	.02 – .02¾	.02½– .02¾
Ammonia, anhydrous, cyl., lb	.15½–......	.15½–......	.15½–.16
tanks, lb	.04½–......	.04½–......	.04½–.16
Ammonium carbonate, powd. tech., casks, lb	.08 – .12	.08 – .12	.08 – .12
Sulphate, wks, cwt	1.40 –......	1.40 –......	1.475–......
Amylacetate tech., tanks, lb	.9½–......	.09½– .12	.11 – .11½
Antimony Oxide, bbl., lb	.11 – .12	.11 – .12	.12½– .13
Arsenic, white, powd., bbl., lb	.03 – .03½	.03 – .03½	.03 – .03½
Red, powd., kegs, lb	.15¾– .16	.15¾– .16	.15¾– .16
Barium carbonate, bbl., ton	52.50 –57.50	52.50 –57.50	52.50 –57.50
Chloride, bbl., ton	79.00 –81.00	79.00 –81.00	79.00 –81.00
Nitrate, casks, lb	.07 – .08	.07 – .08	.07 – .08
Blanc fixe, dry, bbl., lb	.03½– .04	.03½– .04	.03½– .04
Bleaching powder, f. o. b., wks., drums, cwt	2.00 – 2.10	2.00 – 2.10	2.00 – 2.10
Borax, gran., bags, ton	48.00 –51.00	48.00 –51.00	46.00 –51.00
Bromine, cs., lb	.30 – .32	.30 – .32	.30 – .32
Calcium acetate, bags	1.65 –......	1.65 –......	1.65 –......
Arsenate, dr., lb	.06¾– .07	.06¾– .07	.06¾– .07
Carbide drums, lb	.05 – .06	.05 – .06	.05 – .06
Chloride, fused, dr., del., ton	21.50 –24.50	21.50 –24.50	21.50 –24.50
flake, dr., del., ton	23.00 –25.00	23.00 –25.00	23.00 –25.00
Phosphate, bbl., lb	.07½– .08	.07½– .08	.07½– .08
Carbon bisulphide, drums, lb	.05 – .06	.05 – .06	.05 – .06
Tetrachloride drums, lb	.04¾– .05½	.04¾– .05½	.05½– .06
Chlorine, liquid, tanks, wks., lb	1.75 –......	2.00 –......	2.15 –......
Cylinders	.05½– .06	.05½– .06	.05½– .06
Cobalt oxide, cans, lb	1.67 – 1.70	1.67 – 1.70	1.67 – 1.70
Copperas, bgs., f. o. b., wks., ton	15.00 –16.00	15.00 –16.00	15.00 –16.00
Copper carbonate, bbl., lb	.10 – .16½	.10 – .16½	.09 – .16
Sulphate, bbl., cwt	4.50 – 4.75	4.50 – 4.75	4.25 – 4.50
Cream of tartar, bbl., lb	.22¾– .23	.22¾– .23	.19½– .20
Diethylene glycol, dr., lb	.22 – .23	.22 – .23	.22 – .23
Epsom salt, dom., tech., bbl., cwt	1.80 – 2.00	1.80 – 2.00	1.80 – 2.00
Ethyl acetate, drums, lb	.061–......	.061–......	.06½–......
Formaldehyde, 40%, bbl., lb	.05¾– .06½	.05¾– .06½	.05¾– .6½
Furfural, dr., lb	.10 – .17½	.10 – .17½	.10 – .17½
Fusel oil, ref. drums, lb	.12½– .14	.12½– .14	.12½– .14
Glaubers salt, bags, cwt	.95 – 1.00	.95 – 1.00	.95 – 1.00
Glycerine, c.p., drums, extra, lb	.12½–......	.12½–......	.15½–......
Lead:			
White basic carbonate, dry casks, lb	.07 –......	.07 –......	.06¾–......
White, basic sulphate, sck., lb	.06½–......	.06½–......	.06¾–......
Red, dry, sck., lb	.0735–......	.0735–......	.074–......
Lead acetate, white crys., bbl., lb	.10 – .11	.10 – .11	.11 – .12
Lead arsenate, powd., bbl., lb	.11 – .11½	.11 – .11½	.13 – .13½
Lime, chem., bulk, ton	8.50 –......	8.50 –......	8.50 –......
Litharge, pwd., csk., lb	.0635–......	.0635–......	.06 –......
Lithophone, bags, lb	.04¼– .04¾	.04¼– .04¾	.04½– .05
Magnesium carb., tech., bags, lb	.06 – .06½	.06 – .06½	.06 – .06½

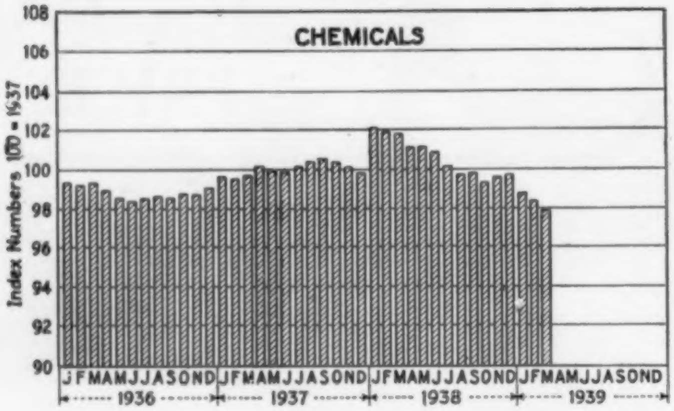
The accompanying prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to March 13

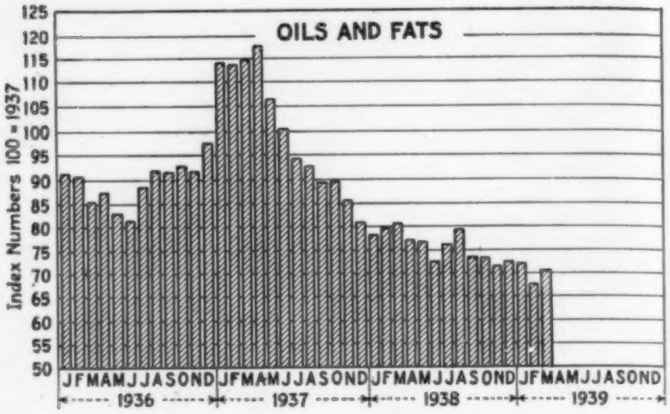
	Current Price	Last Month	Last Year
Methanol, 95%, tanks, gal	.31 –......	.31 –......	.31 –......
97%, tanks, gal	.32 –......	.32 –......	.32 –......
Synthetic, tanks, gal	.33 –......	.33 –......	.33 –......
Nickel salt, double, bbl., lb	.13 – .13½	.13 – .13½	.13 – .13½
Orange mineral, csk., lb	.10½–......	.10½–......	.10½–......
Phosphorus, red, cases, lb	.40 – .42	.40 – .42	.40 – .42
Yellow, cases, lb	.18 – .25	.18 – .25	.24 – .30
Potassium bichromate, casks, lb	.08¾– .09	.08¾– .09	.08¾– .09
Carbonate, 80–85%, calc. csk., lb	.06½– .07	.06½– .07	.06½– .07
Chlorate, powd., lb	.09¼–......	.09¼–......	.09¼–......
Hydroxide (c'stic potash) dr., lb	.07 – .07½	.07 – .07½	.07 – .07½
Muriate, 80% bgs., unit	.53½–......	.53½–......	.53½–......
Nitrate, bbl., lb	.05½– .06	.05½– .06	.05½– .06
Permanganate, drums, lb	.18½– .19	.18½– .19	.18½– .19
Prussate, yellow, caks, lb	.14 – .15	.14 – .15	.15 – .16
Sal ammoniac, white, casks, lb	.05 – .05½	.05 – .05½	.05 – .05½
Salsoda, bbl., cwt	1.00 – 1.05	1.00 – 1.05	1.00 – 1.05
Salt cake, bulk, ton	13.00 –15.00	13.00 –15.00	13.00 –15.00
Soda ash, light, 58%, bags, contract, cwt	.105 –......	1.05 –......	1.05 –......
Dense, bags, cwt	1.10 –......	1.10 –......	1.10 –......
Soda, caustic, 76%, solid, drums, contract, cwt	2.30 – 3.00	2.30 – 3.00	2.30 – 3.00
Acetate, works, bbl., lb	.04 – .05	.04 – .05	.04½– .05
Bicarbonate, bbl., cwt	1.70 – 2.00	1.70 – 2.00	1.75 – 2.00
Bichromate, casks, lb	.06¾– .07	.06¾– .07	.06¾– .07
Bisulphate, bulk, ton	15.00 –16.00	15.00 –16.00	15.00 –16.00
Bisulphite, bbl., lb	.03¾– .04	.03¾– .04	.03¾– .04
Chlorate, kegs, lb	.06¼– .06½	.06¼– .06½	.06¼– .06½
Cyanide, cases, dom., lb	.14 – .15	.14 – .15	.16½– .17
Fluoride, bbl., lb	.07½– .08	.07½– .08	.07½– .08
Hyposulphite, bbl., cwt	2.40 – 2.50	2.40 – 2.50	2.40 – 2.50
Metasilicate, bbl., cwt	2.20 – 3.20	2.20 – 3.20	2.15 – 3.15
Nitrate, bags, cwt	1.45 –......	1.45 –......	1.45 –......
Nitrite, casks, lb	.06¾– .07	.06¾– .07	.07 – .08
Phosphate, dibasic, bags, lb	1.85 –......	1.85 –......	1.85 – .024
Prussiate, yel. drums, lb	.09½– .10	.09½– .10	.10 – .11
Silicate (40° dr.) wks., cwt	.80 – .85	.80 – .85	.80 – .85
Sulphide, fused, 60–62%, dr., lb	.02¾– .03½	.02¾– .03	.02¾– .03
Sulphite, crys., bbl., lb	.02¼– .02½	.02¼– .02½	.02¼– .02½
Sulphur, crude at mine, bulk, ton	16.00 –......	16.00 –......	18.00 –......
Chloride, dr., lb	.03 – .04	.03 – .04	.03 – .04
Dioxide, cyl., lb	.07 – .08	.07 – .08	.07 – .07½
Flour, bag, cwt	1.60 – 3.00	1.60 – 3.00	1.60 – 3.00
Tin Oxide, bbl., lb	.50 –......	.50 –......	.47 –......
Crystals, bbl., lb	.36 –......	.35½–......	.33 –......
Zinc. chloride, gran., bbl., lb	.05 – .06	.05 – .06	.05 – .06
Carbonate, bbl., lb	.14 – .15	.14 – .15	.14 – .15
Cyanide, dr., lb	.33 – .35	.33 – .35	.36 – .38
Dust, bbl., lb	.06½–......	.06½–......	.06¾–......
Zinc oxide, lead free, bag., lb	.06½–......	.06½–......	.06½–......
5% lead sulphate, bags, lb	.06½–......	.06½–......	.06½–......
Sulphate, bbl., cwt	2.75 – 3.00	2.75 – 3.00	3.15 – 3.60

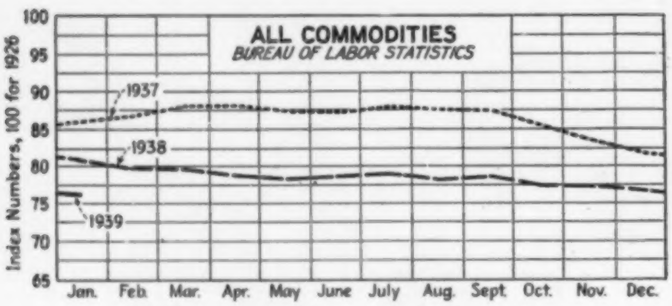
OILS AND FATS

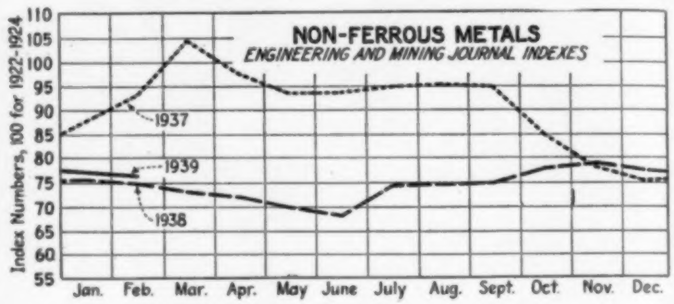
	Current Price	Last Month	Last Year
Castor oil, 3 bbl., lb	$0.09½–$0.10	$0.09½–$0.10	$0.09½–$0.10
Chinawood oil, bbl., lb	.15 –......	.14½–......	.15 –......
Coconut oil, Ceylon, tank, N. Y., lb	.03½–......	.03 –......	.03½–......
Corn oil crude, tanks (f. o. b. mill), lb	.06½–......	.05¾–......	.07½–......
Cottonseed oil, crude (f. o. b. mill), tanks, lb	.05¾–......	.05¾–......	.06½–......
Linseed oil, raw car lots, bbl., lb	.088–......	.085–......	.099–......
Palm, casks, lb	.03½–......	.03½–......	.04½–......
Peanut oil, crude, tanks (mill), lb	.06½–......	.05¾–......	.06¾–......
Rapeseed oil, refined, bbl., gal	.80 –......	.80 –......	.90 –......
Soya bean, tank, lb	.05½–......	.04¾–......	.06½–......
Sulphur (olive foots), bbl., lb	.07 –......	.07 –......	.09½–......
Cod, Newfoundland, bbl., gal	.38 –......	.38 –......	.52 –......
Menhaden, light pressed, bbl., lb	.07 –......	.07 –......	.074–......
Crude, tanks (f. o. b. factory), gal	.30 –......	.30 –......	.37½–......
Grease, yellow, loose, lb	.04¾–......	.04¾–......	.04¾–......
Oleo stearine, lb	.06¾–......	.06¾–......	.07¾–......
Oleo oil, No. 1	.07½–......	.07½–......	.09½–......
Red oil, distilled, d.p. bbl., lb	.07¾–......	.07¾–......	.09¾–......
Tallow extra, loose, lb	.05¾–......	.05¾–......	.05½–......

Chem. & Met.'s Weighted Price Indexes









COAL-TAR PRODUCTS

	Current Price	Last Month	Last Year
Alpha-napthol, crude bbl., lb.	$0.52 –$0.55	$0.52 –$0.55	$0.52 –$0.55
Alpha-naphthylamine, bbl., lb.	.32 – .34	.32 – .34	.32 – .34
Aniline oil, drums, extra, lb.	.15 – .16	.15 – .16	.15 – .16
Aniline, salts, bbl., lb.	.22 – .24	.22 – .24	.22 – .24
Benzaldehyde, U.S.P., dr., lb.	.85 – .95	.85 – .95	.85 – .95
Benzidine base, bbl., lb.	.70 – .75	.70 – .75	.70 – .75
Benzoic acid, U.S.P., kgs., lb.	.54 – .56	.54 – .56	.52 – .54
Benzyl chloride, tech., dr., lb.	.23 – .25	.23 – .25	.25 – .27
Benzol, 90%, tanks, works, gal.	.16 – .18	.16 – .18	.16 – .18
Beta-napthol, tech., drums, lb.	.23 – .24	.23 – .24	.23 – .24
Cresol, U.S.P., dr., lb.	.10 – .11	.10 – .11	.12 – .13
Cresylic acid, dr., wks., gal.	.69 – .71	.69 – .71	.89 – .92
Diethylaniline, dr., lb.	.40 – .45	.40 – .45	.50 – .55
Dinitrophenol, bbl., lb.	.23 – .25	.23 – .25	.23 – .25
Dinitrotoluen, bbl., lb.	.15 – .16	.15 – .16	.15 – .16
Dip oil, 15%, dr., gal.	.23 – .25	.23 – .25	.23 – .25
Diphenylamine, bbl., lb.	.32 – .36	.32 – .36	.32 – .36
H-acid, bbl., lb.	.50 – .55	.50 – .55	.50 – .55
Naphthalene, flake, bbl., lb.	.05¾– .06	.05¾– .06	.07¼– .07¾
Nitrobenzene, dr., lb.	.08 – .09	.08 – .09	.08 – .09
Para-nitraniline, bbl., lb.	.47 – .49	.47 – .49	.45 – .47
Phenol, U.S.P., drums, lb.	.14¼–......	.14¼–......	.14¼–......
Picric acid, bbl., lb.	.35 – .40	.35 – .40	.35 – .40
Pyridine, dr., gal.	1.55 – 1.60	1.55 – 1.60	1.55 – 1.60
Resorcinal, tech., kegs, lb.	.75 – .80	.75 – .80	.75 – .80
Salicylic acid, tech., bbl., lb.	.33 – .40	.33 – .40	.34 – .40
Solvent naptha, w.w., tanks, gal.	.26 –......	.26 –......	.30 –......
Tolidine, bbl., lb.	.86 – .88	.86 – .88	.88 – .90
Toluene, tanks, works, gal.	.27 –......	.27 –......	.35 –......
Xylene, com, tanks, gal.	.26 –......	.26 –......	.35 –......

MISCELLANEOUS

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton	$22.00–$25.00	$22.00–$25.00	$22.00–$25.00
Casein, tech., bbl., lb.	.07¾– .11	.08½– .11	.09¾– .12
China clay, dom., f.o.b. mine, ton.	8.00 –20.00	8.00 –20.00	8.00 –20.00
Dry colors			
Carbon gas, black (wks.), lb.	.02¼– .30	.02¼– .30	.02½– .30
Prussian blue, bbl., lb.	.36 – .37	.36 – .37	.36 – .37
Ultramarine blue, bbl., lb.	.10 – .26	.10 – .26	.10 – .26
Chrome green, bbl., lb.	.21 – .30	.21 – .30	.21 – .27
Carmine red, tins, lb.	4.00 – 4.40	4.00 – 4.40	4.00 – 4.40
Para toner, lb.	.75 – .80	.75 – .80	.75 – .80
Vermilion, English, bbl., lb.	1.58 – 1.60	1.56 – 1.58	1.55 – 1.65
Chrome yellow, C.P., bbl., lb.	.14½– .15½	.14½– .15½	.14¼– .15¼
Feldspar, No. 1 (f.o.b. N.C.), ton.	6.50 – 7.50	6.50 – 7.50	6.50 – 7.50
Graphite, Ceylon, lump, bbl., lb.	.06 – .06½	.06 – .06½	.06 – .06½
Gum copal Congo, bags, lb.	.06 – .30	.06 – .30	.08 – .30
Manila, bags, lb.	.07 – .14	.07 – .14	.09 – .14
Damar, Batavia, cases, lb.	.16 – .24	.16 – .24	.16 – .24
Kauri cases, lb.	.17½– .60	.17½– .60	.18½– .60
Kieselguhr (f.o.b. N. Y.), ton	50.00 –55.00	50.00 –55.00	50.00 –55.00
Magnesite, calc, ton	50.00 –......	50.00 –......	50.00 –......
Pumice stone, lump, bbl., lb.	.05 – .07	.05 – .08	.05 – .07
Imported, casks, lb.	.03 – .04	.03 – .04	.03 – .04
Rosin, H., bbl.	7.00 –......	6.50 –......	7.05 –......
Turpentine, gal.	.34 –......	.30½–......	.31 –......
Shellac, orange, fine, bags, lb.	.20 –......	.20 –......	.21 –......
Bleached, bonedry, bags, lb.	.19 –......	.19 –......	.17 –......
T. N. Bags, lb.	.10½–......	.10½–......	.12 –......
Soapstone (f.o.b. Vt.), bags, ton.	10.00 –12.00	10.00 –12.00	10.00 –12.00
Talc, 200 mesh (f.o.b. Vt.), ton.	8.00 – 8.50	8.00 – 8.50	8.00 – 8.50
300 mesh (f.o.b. Ga.), ton	7.50 –10.00	7.50 –10.00	7.50 –11.00
225 mesh (f.o.b. N. Y.), ton	13.75 –......	13.75 –......	13.75 –......

INDUSTRIAL NOTES

THE DOW CHEMICAL CO., Midland, Mich., has licensed Hills-McCanna Co., 2349 Nelson St., Chicago, to fabricate Dowmetal in the form of sand castings.

PITTSBURGH PIPING & EQUIPMENT CO., Pittsburgh, has appointed C. H. Beckwith as district manager of the Chicago sales territory with headquarters in the Peoples Gas Bldg., Chicago and the General Motors Bldg., Detroit.

COPPUS ENGRAVING CORP., Worcester, Mass., has engaged Edwin L. Dennis as chief combustion engineer. Mr. Dennis is the inventor of Coppus-Dennis Fanmix rotary gas burner.

ROLLER-SMITH CO., has moved its executive offices from 233 Broadway, New York, to its plant at Bethlehem, Pa. District sales agencies in New York and elsewhere are not affected.

THE MEDHART CO., St. Louis, announces that George S. Denithorne has retired as district sales manager. Mr. Denithorne will become a general consulting engineer at State College, Pa.

NATIONAL RADIATOR CORP., is now represented in the Chicago territory by the Faville-LeVally Corp., 140 S. Dearborn St., and in the New York territory by Eastern Steam Specialty Co., Inc., 125 Barclay St.

COMMERCIAL SOLVENTS CORP., New York, will move its general offices on May 1 from 230 Park Ave. to 17 East 42d St.

WAILES DOVE-HERMISTON CORP., New York, has appointed as distributors: Branch-Krachy Co., Houston, Texas; R. W. Hudgins & Son, Norfolk, Va.; the James Walker Co., Baltimore; and Industries Supply Co., San Diego, Calif.

AMERICAN CHAIN & CABLE CO., York, Pa., has transferred G. B. Kutz from Philadelphia to York where he will act as assistant to the general manager of sales, American Chain Division. R. E. Greenwood succeeds Mr. Kutz as district sales manager at Chicago.

New CONSTRUCTION

Where Plants Are Being Built in Process Industries

	Current Projects		Cumulative 1939	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	....	....	$160,000	$40,000
Middle Atlantic	$280,000	$240,000	2,510,000	148,000
South	2,253,000	160,000	4,043,000	135,000
Middle West	140,000	130,000	410,000	140,000
West of Mississippi	505,000	240,000	1,185,000	580,000
Far West	....	190,000	80,000	676,000
Canada	450,000	....	3,250,000	115,000
Total	$3,628,000	$960,000	$11,638,000	$1,834,000

PROPOSED WORK

Chemical Plant—A. C. Chemical Co., Ltd., W. E. Seaborn, Mgr., Moose Jaw, Sask., Can., is having plans prepared for an industrial plant. Estimated cost $50,000.

Chemical Plant—Hooker Electro Chemical Co., Niagara Falls, N. Y., will soon award the contract for an addition to its plant. W. A. Cannon, 2637 Main St., Niagara Falls, Archt. Estimated cost will exceed $100,000.

Distillery—L. J. MacGuiness & Co., Ltd., distillers, Riverside Dr., Windsor, Ont., Can., has purchased a two acre site on Church St., Mimico, Ont., Can., and plans to construct a plant. The Company will be in the market for bottling machinery.

Distillery—Melschers Distilleries, Ltd., 437 St. James St., W., Montreal, Que., Can., is having plans prepared for an addition to its tank storage building at Berthierville, Que. C. David, 1440 St. Catherine St., W., Montreal, Archt. Estimated cost $40,000.

Factory—Eastman Kodak Co., Kodak Park, Rochester, N. Y., plans to construct an addition to its factory. Estimated cost will exceed $40,000.

Gas Plant—Iowa Public Service Co., Waverly, Ia., plans to construct a gas manufacturing plant.

Gas System—City, Broken Bow, Okla., plans to construct a natural gas or a Butane gas system in Broken Bow. Estimated cost $25,000.

Gypsum Plant—National Gypsum Co., Delaware Ave., Buffalo, N. Y., plans to construct an addition to its plant at Clarence, Center Co., N. Y. Estimated cost $40,000.

Industrial Plant—Scientific Equipment Laboratories, Ltd., R. W. Ross, Mgr., Regina, Sask., Can., plans to construct a plant for extraction of oil and other products from Alberta tar sands, to have a capacity of 25 tons per day. Estimated cost $75,000.

Oil Refinery—Central Refiners, Ltd., Brandon, Man., Can., plans to construct a cracking unit to increase its daily capacity by 1500 bbls. Estimated cost will exceed $40,000.

Oil Refinery—Evansville Refining Co., Evansville, Ind., has acquired a 38-acre tract near Evansville and plans to construct a refinery to have a daily capacity of 3000 bbls. R. T. Hertzog, Kilgore, Tex., and J. D. Wrather, Overton, Tex., are officials of the Company. Estimated cost including equipment $60,000.

Oil Refinery—Lake State Oil & Refining Co., recently organized, R. W. Lewis, Pres., Bloomingdale, Mich., plans to construct a refinery at the east end of the village along the right-of-way of the Michigan Central R. R.

Oil Refinery—North American Refining Co., Chinook, Mont., plans to construct a 500 bbl. oil refinery. Mark Vrooman, Shelby, Mont., Superv. Engr.

Oil Refinery—Valvoline Oil Co., Butler, Pa., plans to improve its East Butler refinery. C. W. Luton, Vice Pres. in charge. Estimated cost $50,000.

Oil Terminal—Gulf Refining Co., 1200 East Main St., Chattanooga, Tenn., has purchased a 28 acre site on the north side of the Tennessee River and plans to construct a river terminal for barging gasoline and oils to Chattanooga. Estimated cost $300,000.

Research Laboratory—Caliborn Products, Inc., 51 Lakeside Ave., West Orange, N. J., plans to construct a 2 story research laboratory. Estimated cost $50,000.

Rayon Mill—American Tubize Corp., Rome, Ga., plans to construct an addition to its mill. Robert & Co., Bona Allen Bldg., Atlanta, Ga., Archts.

Rubber Factory—Pharis Tire & Rubber Co., Newark, O., will soon award the contract for a 1 story addition to its factory here. Estimated cost $40,000.

Sugar Beet Refinery—Syndicate c/o Homer Lockhart, 197 North Christina St., Sarnia, Ont., Can., is negotiating for a site for the construction of a beet sugar refinery. Estimated cost $100,000.

Tobacco Factory—American Tobacco Co., 26th and Cary St., Richmond, Va., is receiving bids for the construction of a factory and warehouse at Richmond. Schmidt, Garden & Erikson, Archts., 104 South Michigan Ave., Chicago, Ill. Estimated cost $600,000.

Tobacco Factory—United States Tobacco Co., 4325 West 5th St., Chicago, Ill., will soon award the contract for the construction of a factory on Petersburg Pike, Richmond, Va. Estimated cost $160,000.

Storage Tanks—Standard Oil Co., Fidelity Bldg., Duluth, Minn., J. W. Honomichl, division manager, plans to construct a 4 story storage tank building on Rene St. Estimated cost $400,000.

Storage Tanks—Shell Union Oil Corp., H. H. Bird, Dist. Mgr., First National Bank Bldg., Charlotte, N. C., plans to construct an addition to its bulk plant, also additional storage tanks. Estimated cost $62,500.

Vegetable Oil Tanks—Lever Bros., Ltd., 7 Eastern Ave., Toronto, Ont., Can., will soon take bids for the construction of vegetable oil tanks. Estimated cost $5,000.

Paper Mill Equipment—Hinde & Dauch Paper Co., of Canada, 2195 Masson St., Montreal, Que., Can., will call for bids soon for new equipment for its Montreal and Toronto Mills. Estimated cost $100,000.

CONTRACTS AWARDED

Acid Reclaiming Plant—American Viscose Corp., Roanoke, Va., has awarded the contract for a 4 story acid reclaiming plant to J. P. Pettyjohn Construction Co., Lynchburg, Va. Estimated $160,000.

Factory—Bausch & Lomb Optical Co., St. Paul St., Rochester, N. Y., has awarded the contract for an addition to its factory to John B. Pike & Son, Circle St. Estimated cost $50,000.

Hide House—A. F. Gallun & Sons, 1818 North Water St., Milwaukee, Wis., have awarded the contract for the construction of a 1 story, 45x147 ft. hide house at their tannery to Dahlman Construction Co., P. O. Box 1184; reinforcing steel to W. H. Pipkorn Co., 1548 West Bruce St.; structural steel to Lakeside Bridge & Steel Co., 3700 West Villard Ave. Total estimated cost $40,000.

Oil Refinery—General Petroleum Corp. of California, 417 Montgomery St., San Francisco, Calif., has awarded the contract for tank storage facilities and mooring dock at Napa, Calif., to F. C. Stolte, 1405 San Antonio Ave., Alameda, Calif. Estimated cost will exceed $40,000.

Laboratory—U. S. Government, Bureau of Mines Bldg., Pittsburgh, Pa., has awarded the contract for the construction of a laboratory and shop at 4800 Forbes St., Pittsburgh, to B. L. Wimmer Co., Inc., 2440 Maple Ave., Pittsburgh. Estimated cost $150,000.

Paint Factory—Rust-Oleum Corp., 1928 Grand Ave., Chicago, Ill., has awarded the contract for a paint factory at Evanston, Ill., to Robert Black Co., 122 South Michigan Ave., Chicago. Estimated cost $40,000.

Paper Box Factory—Agar Manufacturing Corp., Whippany, N. J., has awarded the contract for the first five units of a paper box factory at 2100 Kansas Ave., Kansas City, Kan., to Fogel Construction Co., Reliance Bldg., Kansas City, Mo., about $200,000.

Paper Mill—Superior Paper Products, Ingram, Pa., have awarded the contract for a paper mill in Robinson Township, Allegheny Co., to Clayton M. Morris & Son, 840 Fifth St., Coraopolis, Pa. Estimated cost $40,000.

Plant—Cuero Cotton Oil & Manufacturing Co., Cuero, Tex., will construct a sweet feed mill plant. Work will be done by owner. Estimated cost $40,000.

Processing Plant—Eastman Kodak Co., 1017 North Los Palmos Ave., Los Angeles, Calif., has awarded the contract for the construction of a 2 story, 55x132 ft. Class "A" processing plant to H. A. McMurphy, 6347 Eleanor Ave., Los Angeles. Estimated cost $150,000.

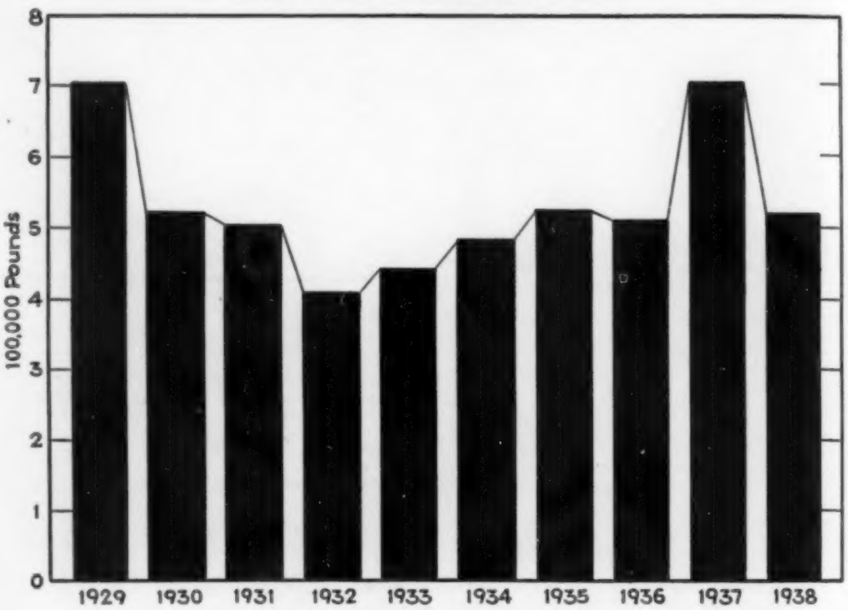
Warehouse—Goodyear Tire & Rubber Co., c/o C. Slusser, 1144 East Market St., Akron, O., has awarded the contract for the construction of a 2 story, 100x150 ft. warehouse to H. K. Ferguson Co., Hanna Bldg., Cleveland, Ohio. Estimated cost $50,000.

EXPORT TRADE IN SODIUM COMPOUNDS SHOWS EFFECTS OF VARIOUS INFLUENCES

GIVING consideration only to the annual totals, our export trade in sodium compounds—not including nitrate of soda which is classified under the fertilizer group—has followed closely the general tenor of worldwide industrial conditions. From 1929 through 1932, the tonnage movement was progressively downward which coincides with the varying status of business throughout the greater part of the world during those depression years. From 1932 through 1937, the movement was reversed and, with the exception of 1936, each year registered a gain in outward shipments over those for the preceding year. The decline in business in the latter part of 1937 and the early part of 1938 resulted in a marked drop in foreign buying with the result that exports in 1938 were brought down close to the 1936 total.

In the accompanying tabulation, export trade in the principal sodium salts is traced through the 10-year period, 1929-1938. A study of these figures brings into sharp relief convincing evidence that developments within the domestic chemical industry in recent years have played an important role in holding in check our trade with outside markets. Standing out most conspicuously is the tremendous drop in the export statistics for the unspecified sodium compounds. For 1929, exports of the "All Other" group were reported in excess of 240 million pounds with an almost unbroken yearly decline in volume to the approximate 16 million pounds credited for 1938. Detailed statistics—giving the name and quantity exported for each sodium compound making up this "All Other" classification—are not available. But the export data for 1929 include 19,192,863 lb. of modified sodas, 968,204 lb. of lye, and 3,331,630 lb. of sodium sulphate. Canadian statistics reveal that in 1929, 21,308 tons or 42,616,000 lb. of salt cake were shipped to Canada from the United States. In earlier years, our exports of niter cake were of fairly large proportions, for instance, in 1931 our official figures placed such exports at 26,702,591 lb. It is evident, therefore, that the last decade has brought a marked falling off in our export shipments of these two chemicals which, to a considerable extent, explains the decline in outward shipments of "All Other" sodium compounds.

Export trade in sodium compounds



Referring to production figures, it will be found that the domestic output of niter cake in 1929 was 111,522 tons which fell to 30,558 tons in 1933. Production of salt cake in the same years was 206,612 tons and 143,148 tons respectively. Up to 1927 the greater part of domestic hydrochloric acid was obtained by treating niter cake with salt. Salt cake was a co-product of this operation and this was by far the largest source of our chemical salt cake supply. Niter cake, in turn was a byproduct of nitric acid production and when acid makers changed their process to that employing the oxidation of ammonia, the supply of niter cake dwindled and makers of hydrochloric acid changed their process of manufacture to others which either cut in half salt cake production or eliminated it entirely.

Among the specified sodium compounds which have failed to hold up in export trade is silicate of soda. In 1929, foreign markets took close to 67 million pounds of this chemical and in 1938, export business involved but little more than 12 million pounds. Canada was the largest buyer of silicate and the loss of Canadian business was the largest factor in reducing exports. Manufacture of silicate of soda in this country has undergone changes in recent years as a consequence of the trend toward decentralization of plants. Consumers who use the material in solution found it economically desirable to eliminate the freight charge—including the freight on water—by having a source of supply near at hand. This idea, successfully carried out in this country, had similar application in Canada and the loss of silicate business with that country corresponds quite closely with growth of silicate production in Canada.

Domestic Exports of Sodium Compounds

	1929 1000 lb.	1930 1000 lb.	1931 1000 lb.	1932 1000 lb.	1933 1000 lb.	1934 1000 lb.	1935 1000 lb.	1936 1000 lb.	1937 1000 lb.	1938 1000 lb.
Bichromate and chromate	5,855	4,933	4,407	6,178	9,702	8,350	7,301	6,553	6,321	4,839
Cyanide	1,816	1,242	1,121	839	457	611	1,006	750	889	1,136
Borate	159,768	165,863	173,876	179,282	175,353	207,287	228,805	204,042	307,544	155,038
Silicate	66,735	60,494	58,577	50,343	43,985	21,304	15,758	13,282	15,594	12,099
Soda ash	77,913	65,873	55,277	27,595	56,883	66,863	87,050	88,535	109,469	102,033
Sal Soda	12,395	13,073	9,058	5,723	3,931	2,149	2,286	1,512	2,080	....
Bicarbonate	18,942	19,818	18,711	14,019	14,936	15,196	13,477	16,529	19,271	20,963
Hydroxide	117,390	126,379	131,189	110,977	121,322	131,651	139,138	153,912	204,535	200,047
Phosphate	....	....	6,129	5,686	7,778	10,181	7,111	6,922	5,869	7,635
All other	244,791	60,568	44,324	9,940	11,894	19,519	20,839	20,103	31,624	16,196
	705,605	518,243	502,669	410,582	446,241	483,111	522,862	512,140	703,196	519,986